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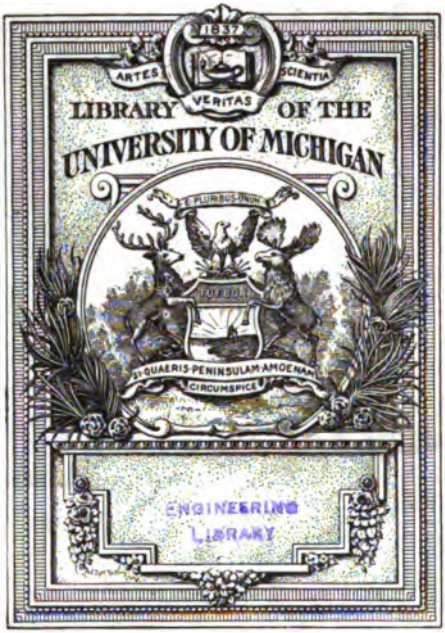

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FOR THE

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BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Under authority of special acts of Congress.—(1) Bridge of the city of Monroe, La., across Ouachita River at Desiard street, (2) bridge of the Columbia and Red Mountain Railway Company across Columbia River at Northport, Wash., (3) bridge of Marietta and Williamstown Bridge Company across Ohio River between Marietta, Ohio, and Williamstown, W. Va., (4) bridge of the Mifflin Bridge Company across Monongahela River at McKeesport, Pa., (5) bridge of the Louisville and Portland Bridge Company across the Louisville and Portland Canal, (6) bridge of the Mississippi River, Hamburg and Western Railway Company across Bayou Bartholomew, Ark., (7) bridge of Leflore County, Miss., across Yazoo River at Greenwood, (8) bridge of the Bellaire-Benwood Bridge Company across Ohio River between Bellaire, Ohio, and Benwood, W. Va., 531; (9) bridge of Dale County, Ala., across Choctawhatchee River near Newton, (10) bridge of Dale County, Ala., across Choctawhatchee River near old Hollis Bridge, (11) bridge of the Chicago, Milwaukee and St. Paul Railway Company across Mississippi River between Prairie du Chien, Wis., and North McGregor, Iowa, (12) bridge of Yazoo and Mississippi Valley Railroad Company across Yalobusha River, in Leflore County, Miss., (13) bridge of the Jonesboro, Lake City and Eastern Railroad Company across Lake St. Francis near Lake City, Ark., (14) bridge of the Lewiston Connecting Bridge Company across Niagara River at Lewiston, N. Y., (15) bridge of the Lewiston-Concord Bridge Company across Snake River between Lewiston, Idaho, and Concord, Wash., 532.

Under authority of State laws.—(1) Bridge of the Erie Railroad Company across Passaic River at Newark, N. J., (2) bridge of the city of Boston, Mass., across Fort Point Channel, (3) bridge of Butler and Muhlenberg counties, Ky., across Mud River at or near Rochester, Ky., (4) bridge of the United Railroads of Washington across Wishka River, Wash., (5) bridge of the United Railroads of Washington across Hoquiam River, Wash., (6) bridge of the city of Bridgeport, Conn., across Yellow Mill Pond at Stratford avenue, (7) bridge of the city of Appleton, Wis., across the United States Fox River Canal at Lake street, (8) bridge of Osage County, Mo., across Gasconade River at Rollins Ferry, (9) bridge of Craven County, N. C., across Trent River at Newbern, (10) bridge of the city of Port Huron, Mich., across Black River at Elmwood street, (11) bridge of the city of New York across the channel between City Island and Pelham Bay Park, (12) bridge of Cabell County, W. Va., across Guyandotte River at Salt Rock, (13) bridge of the city of Chicago, Ill., across South Fork of South Branch of Chicago River at Archer avenue, (14) bridge of the city of New York across Harlem River between One hundred and forty-fifth and One hundred and forty-ninth streets, (15) bridge of the Chicago, Burlington and Quincy Railroad Company across Quincy Bay at Quincy, Ill., 533; (16) bridge of the Galveston, Brazos and Southwestern Railway Company across Chocolate Bayou, Tex., (17) temporary bridge of the New York Central and Hudson River Railroad across Spuyten Duyvil Creek, N. Y., (18) bridge of the Detroit and Lima Northern Railway Company across Rouge River at Delray, Mich., (19) bridge of the Southeastern and Atlantic Railroad Company across Southern Branch of Elizabeth River at Norfolk, Va., (20) bridges of the city of New York across Bronx River at Westchester avenue, (21) bridge of the town of Mukwa, Wis., across Wolf River at Northport, in said town, (22) bridge of the Rapid Railroad Company across the northwest corner of Lake St. Clair, Mich., (23) bridge of the Peoria and Pekin Traction Company across Illinois River at Pekin, Ill., (24) bridge of Whatcom County, Wash., across Nooksack River at Orvis Ferry, (25) bridge of the city of Saginaw, Mich., across Saginaw River at Court street, (26) bridge of Bergen County, N. J., across Hackensack River at Anderson street, Hackensack, N. J., (27) bridge of the St. Paul, Minneapolis and Manitoba Railway Company across Steamboat River, Minn., (28) bridge of the St. Paul, Minneapolis and Manitoba Railroad Company across Kabekona Narrows, Minn., 534; (29) bridge of Craven County, N. C., across Neuse River at Newbern, (30) bridges of the Boston and Providence Railroad Corporation, the Old Colony Railroad Company, and the New York, New Haven and Hartford Railroad Company, across Fort Point Channel, Boston Harbor, Mass., (31) bridge of Jefferson County, Tex., across Taylors Bayou, (32) bridge of the Kerckhoff-Cuzner Mill and Lumber Company across a slough of Wilmington Lagoon, inner harbor of San Pedro, Cal., (33) bridge of the Queen Anne's Railroad Company across Lewes Creek at Lewes, Del., (34) bridge of the Eastern Railway Company of Minnesota across Mississippi River in Minnesota, (35) bridge of the Eastern Railway Company of Minnesota across Ball Club River, Minn., (36) bridge of the New Kensington Bridge Company across Allegheny River at New Kensington, Pa., (37) bridge of the Monongahela Connecting Railroad Company across Monongahela River near Thirtieth street, South Side, Pittsburg, Pa., (38) bridge of the Pittsburg and Lake Erie Railroad Company

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APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

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APPENDIX Y.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MISSOURI, AND TO PREVENT THE MISSISSIPPI FROM BREAKING THROUGH INTO CACHE RIVER AT BEECHRIDGE, ABOVE CAIRO, ILLINOIS.

REPORT OF MAJ. THOS. H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between the Ohio and Missouri rivers.
3. Harbor at St. Louis, Missouri.
4. To prevent the Mississippi River from breaking through into Cache River at Beechridge, above Cairo, Illinois.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 16, 1898.

GENERAL: I have the honor to transmit herewith the annual report for the works under my charge for the fiscal year ending June 30, 1898.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers, U. S. A.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Y 1.

REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE MISSOURI RIVER.

When this work was first inaugurated, and for many years afterwards, navigation on the Mississippi River was extremely difficult and dangerous, owing to numerous snags, logs, and other obstructions of like character lodged in the river bed. Some of these had been buoyed in the sand for ages. As the river wandered about through its alluvial bottom, constantly shifting its channel, these would reappear, and in this shifting process, attended by constant erosion of the banks, new trees would tumble into the stream, which in time would become snags and obstructions to navigation. Wrecks of steamboats, barges, flatboats,

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and all manner of river craft were and are from time to time added to these natural obstructions. For the removal of such obstructions appropriations were made as early as 1824. The project adopted in the early stages of the work contemplated the building of suitable boats and operating them by hired crews whenever the stage of water was suitable and funds were available for the work.

The amount expended for this purpose on this reach of the river prior to 1879 can not be given with any reasonable degree of approximation, for the reason that during much of the time appropriations were made at irregular intervals in a lump sum, to be applied to several streams as their needs or the terms of the law might require.

The first specific sum for removing snags, wrecks, etc., from the Mississippi River below the mouth of the Missouri River was appropriated by act of March 3, 1879, and was followed by other appropriations until 1888, when, by the act of August 11 of that year, an annual expenditure for this purpose of $100,000 was authorized. Under this act operations have been carried on continuously and have resulted in great satisfaction to those interested in the commerce and navigation of the river and in great safety to life and property.

This work is now being done through the instrumentality of two large steel-hulled snag boats, *Horatio G. Wright* and *John N. Macomb*, outfitted with all necessary tools and appliances and operated by hired men, which patrol the river between the mouth of the Missouri River and Natchez, Miss., with an occasional visit as far down as New Orleans, La.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1898.

At the beginning of the fiscal year the *H. G. Wright* was laid up in ordinary and undergoing minor repairs at St. Louis, Mo. On August 14, the river having fallen to a stage which would admit of successful work, she left port under command of Capt. R. E. Birch and proceeded on her regular patrol duty, and was constantly at work, when the weather would permit, until April 13, when she was laid up on account of high water. After making some necessary repairs to the coal bunkers the greater portion of the mechanical force of her crew was transferred to the *Macomb*, to assist in putting a new bottom on that boat.

During the last week of November the *Wright* worked at the wreck of the *Golden City*, about 3 miles below Memphis, which, in consequence of a shifting of the channel, had become dangerous to navigation. A large portion of the wreck was removed and the situation very much improved. About 1,000 pounds of dynamite were used in this work.

During the cyclone of May 27, 1896, the steamer *Dolphin No. 2* was capsized and wrecked in St. Louis Harbor, opposite the foot of Olive street. This wreck was a great obstruction in the harbor. On December 15 the *Wright* went to work removing it. Between that date and the end of the month, at intervals when running ice would permit of access to the wreck, it was totally removed. A sunken barge near the foot of Branch street was also removed about this time.

The *J. N. Macomb*, under command of Capt. A. H. Stewart, left St. Louis, Mo., on August 3 and entered upon her season's work, which was concluded February 10. The boat was then laid up in ordinary on account of the stage of water in the river and pending preparations that were being made for replating her bottom.

This boat was built in 1874, and has been in constant service since that time. Her bottom plating had become so pitted and corrugated with rust that she could no longer be operated with safety. Authority

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was obtained to have her replated with mild steel. Proposals for doing the work were advertised for and opened March 4, 1898. But one bid was received, and that was unsatisfactory. The price named for docking was $2,400 and the price per pound for the material was 9.6 cents, both of which were considered too high. The place named for doing the work was Cincinnati, Ohio. This being above the Louisville locks, through which the boat could not pass, it was impracticable to get it to and from that place, except at very high stages of water. The time during which it was proposed to do the work, June 1 to October 20, was too long for it to be out of service.

The bid was rejected and steps at once taken to do the work with the crews of the two snag boats, assisted by other necessary hired labor, purchasing the material in the usual manner, after ten days' advertisement.

Arrangements were made with the Mississippi Valley Marine Railway and Dock Company at Mound City to haul the boat out and block it up, and for use of their yard facilities. This was the only suitable ways for a boat of the width of the *Macomb* that could be found within reach.

The boat arrived at Mound City April 21, and by the 28th had been hauled out and the work of removing the old plating commenced.

By working the men in three shifts of eight hours each the work was pushed forward rapidly. On the 30th of June it was well advanced toward completion. It is expected that the boat will be again in the water ready for service by the end of July.

A summary of the work accomplished by the two snag boats during the fiscal year is found in the following table:

Name.	Snags pulled.	Trees cut.	Drift piles removed.	Wrecks removed.	Miles run.
H. G. Wright	2,026	9,051	17	a2	6,674
J. N. Macomb	2,227	5,805	15		7,071
Total	4,253	14,856	32	a2	13,745

a Two steamboats and 1 barge.

The trees referred to are generally leaning timber in bends of the river or trees that are liable to fall into the water and become obstructions to navigation.

An annual appropriation of an amount not to exceed $100,000 having been made for this work, the snag boats will patrol the river whenever necessary in order to keep the channel free from obstructions such as snags, logs, drift piles, leaning trees, and such wrecks as they may be able with their appliances to remove after the same have been blown to pieces with explosives.

EXPENDITURES.

The amount expended on this work to July 1, 1897, under all specific appropriations since and to include March, 1879, is $1,282,978.36.

Amount expended from current allotment during the fiscal year, $88,915.27. A detailed statement of this expenditure, as required by law, is given in the accompanying tables 1 and 2. The total expenditure during the year, including the outstanding liabilities of $2.47, were $88,917.74.

The work was all done by hired labor. In general the material has been purchased from the lowest bidder for the most suitable article,

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after ten days' advertisement for proposals. In many cases this method was impracticable. Purchases were then made in open market, in the manner usually pursued by private individuals. The work done by the snag boats is of great benefit to the commerce and navigation on the river. Before the work was so completely patrolled as it now is the sinking of steamboats and other river craft by running on snags was a common occurrence. During recent years such disasters seldom happen. Although life and property would seem to be much safer now than formerly, the rate of insurance has not materially decreased.

It is proposed during the coming fiscal year to continue operating these snag boats as provided for in the river and harbor act of August 11, 1888.

The statistics relating to the commerce benefited by the operations of these snag boats will be found in the report of operations for this year for the improvement of the Mississippi River from the mouth of the Missouri to the mouth of the Ohio River.

The headquarters of the snag boats is in St. Louis, which is the nearest port of entry, and which is in the collection district of New Orleans.

The amount of customs collected at St. Louis during the fiscal year was $1,000,632.43.

The amount of internal revenue collected was $8,394,365.65.

Money statement.

Amount to be drawn under section 7, act of August 11, 1888	$88,917.74
June 30, 1898, amount expended during fiscal year	88,915.27
Outstanding liabilities June 30, 1898	2.47
July 1, 1898, amount available for fiscal year 1898–99	100,000.00

Appropriations made by Congress for removing obstructions in Mississippi River.

By act of—		For fiscal year ending—	
March 3, 1879	$100,000.00	June 30, 1892	$98,250.00
June 14, 1880	100,000.00	June 30, 1893	96,497.23
March 3, 1881	80,000.00	June 30, 1894	88,252.46
March 2, 1882	85,000.00	June 30, 1895	100,000.00
July 5, 1884	72,950.63	June 30, 1896	80,496.26
August 5, 1886	56,250.00	June 30, 1897	83,421.64
August 11, 1888	100,000.00	June 30, 1898	88,917.74
For fiscal year ending—		Total	1,371,896.10
June 30, 1890	49,069.17		
June 30, 1891	92,720.97		

Abstract of proposals for replating U. S. snag boat J. N. Macomb, received in response to advertisement dated February 2, 1898, and opened March 4, 1898, at 12 o'clock noon, by Maj. Thomas H. Handbury, Corps of Engineers, at St. Louis, Mo., for work of removing obstructions in Mississippi River.

No.	Name and address of bidder.	Price for docking.	Price for plating per pound, on basis of 182,000 pounds.	Amount.
1	Cincinnati Marine Rwy. Co., Cincinnati, Ohio	$2,400.00	0.9\frac{5}{16}$	$19,872.00

Rejection recommended.

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TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River during the fiscal year 1898, as required by section 7 of the river and harbor act of August 11, 1888.*

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July...	1	M. M. Buck Manufacturing Co	Supplies	$23.99
	2	Western Brass Manufacturing Co	....do	81.50
	3	Robt. D. Patterson Stationery Co	....do	11.21
	4	Sundry persons	Pay roll	355.00
	5	....do	....do	1,390.00
	6	....do	....do	1,375.00
Aug...	1	Adolph J. Bentsen	Supplies	260.87
	2	Louis Becker	Ice	10.80
	3	Wm. Freese	Supplies	97.54
	4	Robert Freise	Milk	13.20
	5	John Lowell	Supplies	265.82
	6	Bauer Grocer Co	....do	235.65
	7	Huse & Loomis Ice and Transportation Co.	Ice	10.50
	8	Aroma Coffee and Spice Co	Coffee	20.00
	9	C. F. Blanke Tea and Coffee Co	Tea	9.00
	10	F. W. Brockman Commission Co	Supplies	71.16
	11	M. M. Buck Manufacturing Co	....do	4.92
	12	Consolidated Coal Co. of St. Louis	Coal	97.50
	13	James M. Houston Grocer Co	Supplies	24.60
	14	Western Electrical Supply Co	....do	16.20
	15	Wm. Barr Dry Goods Co	Repairs	3.00
	16	Moffitt-West Drug Co	Supplies	33.53
	17	M. Dougherty	....do	27.30
	18	Louis Becker	Ice	27.30
	19	Wm. Freese	Supplies	62.75
	20	Scharff-Bernheimer Grocer Co	....do	100.86
	21	Bauer Grocer Co	....do	193.05
	22	Adolph J. Bentzen	....do	64.85
	23	Sylvester Coal Co	Coal	8.00
	24	South St. Louis Foundry	Grate	1.91
	25	David Nicholson	Supplies	125.99
	26	Simmons Hardware Co	....do	2.15
	27	Scharff-Bernheimer Grocer Co	....do	30.82
	28	Big Muddy Coal and Iron Co	Coal	114.37
	29	A. A. Ehrman	Supplies	57.32
	30	C. C. Huthmacher	....do	14.65
	31	L. S. Koerber	....do	31.52
	32	L. P. Laurent	....do	32.20
	33	Matt Monaghan & Co	....do	48.10
	34	Natchez Ice Co	Ice	14.00
	35	John Pichetto	Supplies	35.95
	36	Peatross, Cameron & Co	Coal	165.00
	37	The Laclede Power Co	Supplies	6.43
	38	Pittsburg Coal Co	Coal	137.50
	39	A. Holderby	Milk	3.75
	40	Pittsburg Coal Co	Coal	110.00
	41	J. J. Slover	Supplies	21.49
	42	Jas. A. Tappan	Coal	82.50
	43	Walter & Rust	Supplies	44.61
	44	Sundry persons	Pay roll	500.00
	45	....do	....do	1,775.00
	46	....do	....do	353.00
	47	....do	....do	1,618.34
	48	....do	....do	280.58
	49	Fischer Packing Co	Supplies	40.61
	50	Valentin Resch	....do	32.40
Sept...	1	Aaron Meyers	....do	35.10
	2	E. Berton	Beef	21.00
	3	P. H. Dempsey	Supplies	28.71
	4	Pittsburg Coal Co	Coal	330.00
	5	M. M. Buck Manufacturing Co	Supplies	12.70
	6	H. E. Coffin	....do	39.92
	7	Matt Monaghan & Co	....do	101.55
	8	Pittsburg Coal Co	Coal	110.00
	9	J. J. Slover	Supplies	52.86
	10	Jas. A. Tappan	Coal	220.00
	11	Western Union Telegraph Co	Telegrams	2.00
	12	A. A. Ehrman	Supplies	85.11
	13	Peatross, Cameron & Co	Coal	275.00
	14	John Pichetto	Supplies	33.62
	15	Western Brass Manufacturing Co	....do	25.75
	16	John O'Brien Boiler Works Co	Boiler	298.00
	17	Big Muddy Coal and Iron Co	Coal	238.75
	18	Cairo City Coal Co	....do	214.90
	19	A. Holderby	Milk	3.00
	20	Valentin Resch	Supplies	59.20
	21	Walter & Rust	....do	67.19
	22	Crown Coal and Tow Co	Coal	310.92

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TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
Sept...	23	Sundry persons	Pay roll	$300.00
	24	L. S. Koerber	Supplies	44.05
	25	Sundry persons	Pay roll	1,817.33
	26	.....do	.....do	327.00
	27	.....do	.....do	1,332.50
	28	.....do	.....do	332.17
Oct	1	E. Berton	Beef	24.00
	2	Aaron Meyers	Supplies	45.36
	3	Jas. A. Tappan	Coal	178.75
	4	Adolph J. Bentzen	Supplies	31.18
	5	Cairo City Coal Co	Coal	96.00
	6	Huse & Loomis Ice and Transportation Co.	Ice	11.12
	7	Matt Monaghan & Co	Supplies	147.35
	8	.....do	.....do	95.80
	9	Aaron Meyers	.....do	89.68
	10	Pittsburg Coal Co	Coal	520.00
	11	.....do	.....do	192.50
	12	J. S. Roberts	Meat	7.56
	13	J. J. Slover	Supplies	77.84
	14	John Atkins	.....do	29.15
	15	H. Buchterkirchen	.....do	19.30
	16	Eugene Berton	.....do	29.24
	17	Jno. Lowell	.....do	150.25
	18	Simmons Hardware Co	.....do	12.08
	19	Western Union Telegraph Co	Telegrams	4.08
	20	Aroma Coffee and Spice Co	Coffee	19.38
	21	Big Muddy Coal and Iron Co	Coal	80.06
	22	Bauer Grocer Co	Supplies	293.27
	23	Adolph J. Bentzen	.....do	98.55
	24	F. W. Brockman Commission Co	Bacon	27.00
	25	Louis Landau & Co	Supplies	140.58
	26	Fischer Packing Co	.....do	43.86
	27	Missouri Glass Co	.....do	9.32
	28	David Nicholson	.....do	97.31
	29	J. J. Slover	.....do	35.77
	30	.....do	.....do	86.17
	31	Sundry persons	Pay roll	1,740.33
	32	.....do	.....do	395.33
	33	.....do	.....do	500.00
	34	M. K. Deale	Typewriter and desk	117.00
	35	Moffitt-West Drug Co	Supplies	20.95
	36	Pittsburg Coal Co	Coal	357.50
	37	Jas. A. Tappan	.....do	180.00
	38	Bauer Grocer Co	Supplies	471.30
Nov ...	1	Sundry persons	Pay roll	1,845.00
	2	.....do	.....do	330.00
	3	Victor H. Poss	Services	150.00
	4	Baldwin, Knowlton & Lake	Butter	5.70
	5	Goyer Cold Storage Co	Supplies	39.68
	6	Matt Monaghan & Co	.....do	54.85
	7	Valentin Resch	.....do	13.20
	8	Sylvester Coal Co	Coal	65.00
	9	Walter & Rust	Supplies	50.88
	10	G. D. Williamson	.....do	40.05
	11	Big Muddy Coal and Iron Co	Coal	91.50
	12	Western Electrical Supply Co	Supplies	18.92
	13	Crown Coal and Tow Co	Coal	80.00
	14	Cairo City Coal Co	.....do	156.00
	15	Matt Monaghan & Co	Supplies	116.63
	16	Pittsburg Coal Co	Coal	226.98
	17	J. J. Slover	Supplies	67.06
	18	Western Union Telegraph Co	Telegrams	3.67
	19	Big Muddy Coal and Iron Co	Coal	228.75
	20	Adolph J. Bentzen	Supplies	43.05
	21	Bannantine Galvanized Iron Manufacturing Co.	.....do	3.40
	22	H. L. Ettman & Co	Sponges	5.25
	23	Fischer Packing Co	Supplies	44.31
	24	Missouri Glass Co	.....do	5.97
	25	Paddock-Hawley Iron Co	Rivets	8.75
	26	E. E. Souther Iron Co	Chain	18.38
	27	Simmons Hardware Co	Supplies	37.40
	28	Fairbanks, Morse & Co	.....do	20.07
	29	David Nicholson	Butter	24.75
	30	American Express Co	Express charges	1.00
	31	Valentin Resch	Supplies	21.05
	32	Walter & Rust	.....do	58.07
	33	John J. Ganahl Lumber Co	Lumber	27.50
	34	Hart Coal Co	Coal	37.74
	35	E. H. Warner	Lumber	19.60
	36	A. A. Ehrman	Meat	68.73
	37	International Oil Works, Limited	Oil	8.80

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TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
Nov ...	38	John Pichetto	Supplies	$49.30
	39	Peatross, Cameron & Co	Coal	300.00
	40	Geo. Wenger Machinery and Supplies Manufacturing Co.	Supplies	6.90
	41	Sundry persons	Pay roll	300.00
	42	.....do	.....do	1,820.00
	43	.....do	.....do	318.00
	44	M. M. Buck Manufacturing Co	Pipe	3.30
	45	Sundry persons	Pay roll	1,791.67
	46	.....do	.....do	390.00
Dec....	1	Levi Joy, jr	Dynamite	162.25
	2	L. S. Koerber	Supplies	77.71
	3	Lee Brothers	Dynamite	40.00
	4	Pittsburg Coal Co	Coal	405.00
	5	J. J. Slover	Supplies	60.26
	6	Dan Shea & Co.	Repairs	30.00
	7	Lana Sullivan	Services of James Sullivan, deceased.	28.00
	8	Jas. A. Tappan	Coal	262.44
	9	Baldwin, Knowlton & Lake	Supplies	286.11
	10	H. E. Coffin	.....do	81.19
	11	Matt Monaghan & Co	.....do	97.35
	12	Pittsburg Coal Co	Coal	120.00
	13	J. J. Slover	Meat	68.67
	14	The Oliver-Finnie Grocer Co	Supplies	279.97
	15	Henry Buchterkirchen	Beef	26.20
	16	Cairo City Coal Co	Coal	54.00
	17	Matt Monaghan & Co	Supplies	106.01
	18	Pittsburg Coal Co	Coal	347.37
	19	Cairo City Coal Co	.....do	98.40
	20	Huse & Loomis Ice and Transportation Co.	Ice	16.39
	21	Jere Haldeman	Traveling expenses	7.08
	22	Valentin Resch	Supplies	26.46
	23	Walter & Rust	.....do	39.38
	24	Western Union Telegraph Co	Telegrams	2.71
	25	W. C. Postal	Coal	53.00
	26	Aroma Coffee and Spice Co	Coffee	23.25
	27	F. W. Brockman Commission Co	Supplies	57.04
	28	Bauer Grocer Co	.....do	320.90
	29	A. A. Ehrman	Meats	84.91
	30	John F. Irvine & Son	Coal	75.00
	31	L. S. Koerber	Supplies	50.59
	32	Louis Landau & Co	.....do	12.00
	33	Paddock-Hawley Iron Co	Iron	23.16
	34	John Pichetto	Supplies	69.98
	35	Peatross, Cameron & Co	Coal	144.00
	36	Sylvester Coal Co	.....do	36.50
	37	Big Muddy Coal and Iron Co	.....do	61.00
	38	Sundry persons	Pay roll	300.00
	39	.....do	.....do	1,817.50
	40	.....do	.....do	291.83
	41	.....do	.....do	1,761.17
	42	.....do	.....do	371.50
	43	Western Iron and Supply Co	Diaphragm	.68
	44	Pittsburg Coal Co	Coal	390.00
1898.				
Jan....	1	Jas. A. Tappan	.....do	210.00
	2	Adolph J. Bentzen	Supplies	96.47
	3	Crown Coal and Tow Co	Coal	200.00
	4	Fischer Packing Co	Supplies	77.01
	5	Fisher & Co	.....do	*33.50
	6	Matt Monaghan & Co	.....do	118.20
	7	Repauno Chemical Co	Dynamite	90.75
	8	.....do	Supplies	60.98
	9	Cairo City Coal Co	Coal	118.20
	10	Valentin Resch	Supplies	24.85
	11	Western Union Telegraph Co	Telegrams	3.48
	12	G. D. Williamson	Supplies	6.75
	13	Walter & Rust	.....do	31.10
	14	Big Muddy Coal and Iron Co	Coal	68.62
	15	Adolph J. Bentzen	Supplies	46.93
	16	Fischer Packing Co	.....do	62.04
	17	Sylvester Coal Co	Coal	26.00
	18	Crown Coal and Tow Co	.....do	120.00
	19	A. A. Ehram	Supplies	95.00
	20	L. S. Koerber	.....do	73.25
	21	Peatross, Cameron & Co	Coal	213.00
	22	Fisher & Co	Supplies	46.27
	23	John Pichetto	.....do	74.85
	24	Pittsburg Coal Co	Coal	200.00
	25	.....do	.....do	233.75
	26	Sundry persons	Pay roll	205.00

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TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
Jan....	27	Sundry persons	Pay roll	$1,792.50
	28	.....do	.....do	331.50
	29	.....do	.....do	1,788.88
	30	.....do	.....do	360.00
	31	Matt Monaghan & Co	Supplies	48.15
Feb....	1	Brady, Howard & Prewett	.....do	19.00
	2	Jas. A. Tappan	Coal	270.00
	3	Geo. Arnold & Co	Supplies	42.96
	4	Baldwin, Knowlton & Lake	.....do	57.91
	5	Cairo City Coal Co	Coal	242.80
	6	Fisher & Co	Supplies	89.34
	7	Lee Brothers	White lead	26.07
	8	Matt Monaghan & Co	Supplies	97.51
	9	Wm. Wooten	Oak log	5.50
	10	The Oliver-Finnie Grocer Co	Supplies	154.58
	11	Pittsburg Coal Co	Coal	213.07
	12	.....do	.....do	150.00
	13	Dan Shea & Co	Repairs	20.00
	14	Postal Telegraph Cable Co	Telegrams	.20
	15	Western Union Telegraph Co	.....do	2.25
	16	A. Holderby	Milk	2.50
	17	Valentin Resch	Supplies	28.90
	18	Walter & Rust	.....do	46.86
	19	A. Holderby	Milk	2.50
	20	Louis Landau & Co	Supplies	147.57
	21	Valentin Resch	.....do	19.55
	22	Walter & Rust	.....do	41.43
	23	Buxton & Skinner Stationery Co	Job printing	37.49
	24	F. W. Brockman Commission Co	Supplies	32.68
	25	Adolph J. Bentzen	.....do	21.13
	26	Sundry persons	Pay roll	350.00
	27	.....do	.....do	1,815.00
	28	.....do	.....do	297.00
	29	.....do	.....do	1,265.35
	30	.....do	.....do	154.00
	31	Big Muddy Coal and Iron Co	Coal	285.00
Mar....	1	Adolph J. Bentzen	Supplies	49.78
	2	Cairo City Coal Co	Coal	48.40
	3	John Lowell	Supplies	88.21
	4	Aroma Coffee and Spice Co	Coffee	22.50
	5	Bauer Grocer Co	Supplies	127.39
	6	Adolph J. Bentzen	.....do	21.68
	7	Sylvester Coal Co	Coal	40.97
	8	Huse & Loomis Ice and Transportation Co	Ice	7.35
	9	The Consolidated Coal Co. of St. Louis	Coal	39.00
	10	Fischer Packing Co	Supplies	66.09
	11	The Laclede Power Co	.....do	3.25
	12	Paddock-Hawley Iron Co	.....do	25.14
	13	Western Electrical Supply Co	Repairs	17.47
	14	Western Union Telegraph Co	Telegrams	2.70
	15	Big Muddy Coal and Iron Co	Coal	127.50
	16	The Consolidated Coal Co. of St. Louis	.....do	39.00
	17	Cairo City Coal Co	.....do	120.00
	18	A. Holderby	Milk	2.50
	19	Walter & Rust	Supplies	63.83
	20	Valentin Resch	.....do	33.80
	21	The Engineering News Publishing Co	Advertising	5.40
	22	Marine Journal Co	.....do	6.00
	23	Star Publishing Co	.....do	5.40
	24	The Globe Printing Co	.....do	12.15
	25	Harbison Bros. & Co	Supplies	15.48
	26	L. P. Laurent	.....do	19.17
	27	Sundry persons	Pay roll	205.00
	28	.....do	.....do	335.00
	29	.....do	.....do	1,772.67
	30	.....do	.....do	347.33
	31	Adolph J. Bentzen	Supplies	30.66
	32	Fischer Packing Co	.....do	31.47
	33	John Lowell	.....do	75.30
	34	Pittsburg Times	Advertising	7.02
	35	Adolph J. Bentzen	Supplies	97.46
	36	Fisher & Co	.....do	53.55
	37	Matt Monaghan & Co	.....do	76.82
	38	Natchez Ice Co	.....do	17.50
Apr	1	J. P. Greenley	Milk	1.05
	2	Pittsburg Coal Co	Coal	492.09
	3	Pentroea, Cameron & Co	.....do	135.09
	4	H. M. Ehrman	Supplies	60.00
	5	Jas. A. Tappan	Coal	210.00
	6	Western Union Telegraph Co	Telegrams	2.99
	7	Fisher & Co	Supplies	40.95
	8	Matt Monaghan & Co	.....do	40.18

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TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
Apr....	9	Pittsburg Coal Co	Coal	$120.00
	10	Aroma Coffee and Spice Co	Coffee	41.25
	11	J. D. Streett & Co	Oil	14.30
	12	Sylvester Coal Co	Coal	32.00
	13	Schaeffer Bros. & Powell Manufacturing Co.	Candles	8.40
	14	F. W. Brockman Commission Co	Supplies	48.10
	15	Eagle Boat Store Co	Oil	9.32
	16	Grand Laundry Co	Laundry work	5.82
	17	L. M. Rumsey Manufacturing Co	Supplies	93.40
	18	Wrought Iron Range Co	....do	7.75
	19	Big Muddy Coal and Iron Co	Coal	157.50
	20	Hofman Mercantile Co	Supplies	178.62
	21	Louis Landau & Co	....do	214.67
	22	Moffitt West Drug Co	Sapolio	2.50
	23	Hofman Mercantile Co	Supplies	80.92
	24	Louis Landau & Co	....do	178.04
	25	Sundry persons	Pay roll	405.00
	26	....do	....do	133.00
	27	....do	....do	1,325.67
	28	Illinois Steel Co	Steel	2,468.32
	29	Sundry persons	Pay roll	1,496.58
	30	....do	....do	246.25
May...	1	Bucher Bros. & Co	Meat	25.60
	2	Fr. Wm. Freese	Supplies	35.50
	3	P. T. Langan	Lumber	118.40
	4	G. F. Meyer & Co	Nails	3.50
	5	C. Pranger & Son	Milk	3.20
	6	Thos. H. Handbury, Major, Corps of Engineers, U. S. A.	Mileage	12.00
	7	M. M. Buck Manufacturing Co	Supplies	472.30
	8	Adolph J. Bentsen	....do	181.99
	9	F. Bocier	Magnesia covering	41.65
	10	The Consolidated Coal Co. of St. Louis	Coal	32.50
	11	Eau Claire-St. Louis Lumber Co	Lumber	69.32
	12	Walter L. Flower & Co	Oil	17.85
	13	Fischer Packing Co	Supplies	14.17
	14	International Oil Works, Limited	....do	33.40
	15	N. O. Nelson Manufacturing Co	Valves	2.28
	16	Platt & Thornburgh Paint and Glass Co	Supplies	4.00
	17	Simmons Hardware Co	....do	85.38
	18	E. E. Souther Iron Co	Rivets	71.52
	19	Sylvester Coal Co	Coal	6.40
	20	Waters Pierce Oil Co	Oil	82.80
	21	E. H. Warner	Lumber	5.96
	22	Zittlosen Manufacturing Co	Flag	8.75
	23	Sundry persons	Pay roll	19.50
	24	The Distilled Water Ice Manufacturing Co.	Ice	12.40
	25	W. H. Gregg, jr	Supplies	205.60
	26	P. T. Langan	Lumber	11.60
	27	Walter & Rust	Supplies	57.43
	28	F. J. Wehrfritz	....do	58.95
	29	Richard Garstang	Castings	8.39
	30	Sundry persons	Pay roll	81.87
	31	Michael Bennett	Repairs	16.00
	32	Richard Garstang	....do	75.00
	33	Paddock-Hawley Iron Co	Supplies	443.53
	34	John T. Rennie	Bevel gear	3.85
	35	Wm. O. Gibson & Son Grocery Co	Supplies	12.12
	36	Sundry persons	Pay roll	161.56
	37	M. M. Buck Manufacturing Co	Supplies	129.91
	38	E. E. Souther Iron Co	Rivets	387.07
	39	Sylvester Coal Co	Coal	15.00
	40	Thos. H. Handbury, major, Corps of Engineers, U. S. A.	Mileage	5.76
	41	J. M. Tucker	Travel expenses	5.25
	42	H. Senne	Hauling	10.00
	43	Sundry persons	Pay roll	205.00
	44	Wm. C. Stevens	Travel expenses	6 50
	45	John Lowell	Supplies	210.69
	46	Sundry persons	Pay roll	1,618.00
	47	....do	....do	619.17
	48	....do	....do	1,028.84
	49	....do	....do	274.62
June...	1	....do	....do	106.56
	2	....do	....do	928.75
	3	....do	....do	464.00
	4	....do	....do	826.62
	5	....do	....do	59.05
	6	Thos. H. Handbury, major, Corps of Engineers, U. S. A.	Mileage	8.00

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TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
June...	7	P. T. Langan	Iron	$9.55
	8	Winter Bros	Ice	46.80
	9	Walter & Rust	Supplies	215.22
	10	F. J. Wehrfritz	....do	135.71
	11	Geo. J. Fritz Foundry and Machine Co	Castings	72.65
	12	Hofman Mercantile Co	Supplies	39.36
	13	Moffitt-West Drug Co	....do	21.00
	14	Paddock-Hawley Iron Co	....do	56.48
	15	Thos. Sexton Stove and Range Co	Repairs	6.25
	16	E. E. Souther Iron Co	Rivets	38.74
	17	Adolph J. Bentzen	Supplies	27.73
	18	Louis Becker	Ice	14.70
	19	Fr. Wm. Freese	Supplies	47.50
	20	Northwestern Stove Repair Co	....do	8.94
	21	B. Pranger	Milk	6.20
	22	Geo. F. Morits Blank Book Co	Portage book	4.75
	23	G. B. Haldeman	Travel expenses	5.50
	24	Missouri Car and Foundry Co	Lumber	48.45
	25	Schaeffer Bros. & Powell Manufacturing Co.	Candles	8.40
	26	Waters Pierce Oil Co	Oil	40.46
	27	Sundry persons	Pay roll	93.25
	28	....do	....do	246.87
	29	Aroma Coffee and Spice Co	Coffee	22.50
	30	Wm. Barr Dry Goods Co	Supplies	3.96
	31	M. M. Buck Manufacturing Co	....do	139.83
	32	D. Crawford & Co	....do	35.68
	33	R. B. Gray China Co	Dishes	3.80
	34	Howard Ewald & Co	Iron	32.20
	35	Illinois Steel Co	Steel	30.45
	36	Pullman's Palace Car Co	Sleeping-car fare	1.50
	37	Scruggs, Vandervoort & Barney Dry Goods Co.	Supplies	79.76
	38	Simmons Hardware Co	....do	17.24
	39	Waters Pierce Oil Co	Oil	20.23
	40	Western Electrical Supply Co	Supplies	23.65
	41	Western Union Telegraph Co	Telegrams	2.97
	42	Cairo City Coal Co	Coal	98.40
	43	Hofman Mercantile Co	Flour	62.76
	44	G. F. Meyer & Co	Supplies	3.65
	45	Missouri Glass Co	....do	2.43
	46	E. E. Souther Iron Co	Rivets	74.50
	47	Walter & Rust	Supplies	207.91
	48	F. J. Wehrfritz	....do	177.86
	49	Sundry persons	Pay roll	255.63
	50	Gerritzen Bros. & Co	Refilling hektograph	1.65
	51	E. S. Healey	Cement	36.36
	52	Kent & Purdy Paint Co	Supplies	25.65
	53	Moffitt-West Drug Co	....do	35.75
	54	Platt & Thornburgh Paint and Glass Co	Paint brushes	7.72
	55	Shallcross-McCallum Printing and Stationery Co.	Supplies	6.55
	56	Sylvester Coal Co	Coal	40.00
	57	Trorlicht, Duncker & Renard Carpet Co	Supplies	76.35
	58	Louis Becker	Ice	17.50
	59	Buehler-Phelan Paint Manufacturing Co	Turpentine	14.40
	60	M. M. Buck Manufacturing Co	Supplies	27.36
	61	Adolph J. Bentzen	....do	19.71
	62	Fr. Wm. Freese	Meats	26.40
	63	Meyer Brothers Drug Co	Supplies	25.86
	64	B. Pranger	Milk	1.20
	65	E. E. Souther Iron Co	Rivets	35.76
	66	Winter Brothers	Ice	67.60
	67	Sundry persons	Pay roll	405.00
	68	....do	....do	1,856.67
	69	....do	....do	808.94
	70	....do	....do	530.17
	71	....do	....do	845.00
	72	....do	....do	206.08
	73	M. M. Buck Manufacturing Co	Crayons	2.75
	74	Illinois Central Railroad Co	Transportation	11.01
	75	Paddock-Hawley Iron Co	Supplies	51.15
	76	Schaeffer Bros. & Powell Manufacturing Co.	Candles	17.21
	77	Waters Pierce Oil Co	Rosin	37.50
	78	Sundry persons	Pay roll	283.74
	79	....do	....do	319.25
	80	....do	....do	776.44
	81	....do	....do	1,148.75
	82	....do	....do	858.25
	83	....do	....do	379.75

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TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
June...	84	John Rohan & Son Boiler Works Co.....	Boiler	$290.00
	85	E. E. Souther Iron Co.....	Rivets.....	26.83
	86	N. M. Simonds.....	Castings.....	5.00
		Total expended.....	.....	88,915.27
		Outstanding liabilities June 30, 1898.		
		Pullman's Palace Car Co.....	Sleeping-car fare.....	1.50
		Western Union Telegraph Co	Telegrams.....	.97
				88.917.74

TABLE No. 2.—*Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb in connection with work of removing obstructions in Mississippi River during fiscal year ending June 30, 1898.*

Application.	1897.					
	July.	August.	September.	October.	November.	December.
Office expenses	$356.21	$500.00	$302.00	$621.08	$454.27	$202.71
Expenses of snag boat H. G. Wright:						
Crew	1,390.00	1,898.92	2,164.67	.....	4,356.67	2,137.33
Outfit.....	.....	.45	1.50	.....	49.10	.....
Fuel	.....	122.37	974.57	812.50	429.49	707.90
Subsistence.....	.....	799.75	158.10	982.38	395.59	687.89
Supplies	7.34	1.70	5.80	.....	32.27	225.05
Repairs	.....	1.91	303.40	.....	29.95	112.23
Miscellaneous	.....	16.76	.....	10.47	55.00	7.08
Expenses of snag boat J. N. Macomb:						
Crew	1,375.00	2,128.00	2,144.33	2,135.66	2,138.00	2,132.67
Outfit.....	3.00	4.92	.....	21.40	.....	.....
Fuel	.....	592.50	715.00	792.31	756.43	1,338.31
Subsistence.....	.....	1,339.32	372.79	1,029.75	291.72	1,015.29
Supplies	5.00	.....	39.92	58.89	.....	.....
Repairs	100.15	25.63	25.75	.....	18.32	.....
Miscellaneous	.....	16.76	.....	10.48	.....	.....
Total	3,236.70	7,449.49	7,207.83	6,474.92	9,006.81	8,666.96

Application.	1898.						
	January.	February.	March.	April.	May.	June.	Total.
Office expenses.....	$208.43	$352.45	$207.70	$407.99	$205.00	$417.14	$4,335.03
Expenses of snag boat H. G. Wright:							
Crew.....	2,124.00	2,112.00	2,120.00	1,742.33	1,028.34	845.00	21,920.26
Outfit.....	.....	.....	14.65	.....	8.75	199.22	273.67
Fuel	761.57	369.80	418.67	1,024.50	6.40	.....	5,627.77
Subsistence.....	384.67	343.12	633.21	466.74	72.70	200.30	5,124.45
Supplies	167.48	.....	9.94	.....	83.80	.....	533.38
Repairs	.....	5.50	17.47	.....	153.69	136.29	760.44
Miscellaneous.....	.....	.....	.....	.....	.....	10.25	99.56
Expenses of snag boat J. N. Macomb:							
Crew.....	2,148.33	1,419.35	835.00	835.00	835.00	835.00	18,961.84
Outfit.....	.....	.....	.....	93.40	266.20	445.36	834.78
Fuel	623.00	791.07	.....	122.00	32.50	.....	5,763.62
Subsistence	483.70	461.32	266.84	412.04	283.68	329.15	6,291.10
Supplies	4.25	.....	.....	34.52	79.16	61.26	283.00
Repairs	.....	84.16	.....	3,099.74	3,721.25	10,643.79	17,718.79
Miscellaneous.....	.....	.....	35.97	5.32	235.11	86.41	390.05
Total.....	6,910.98	5,938.77	4,559.45	8,244.08	7,012.08	14,209.67	a88,917.74

a Includes $3.47 liabilities incurred during the fiscal year but remaining unpaid on June 30, 1898.

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Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

The object of the improvement is to obtain eventually a minimum depth at standard low water of 6 feet from the mouth of the Missouri River to St. Louis, a distance of 16 miles, and of 8 feet at the same stage of water from St. Louis to the mouth of the Ohio River, 178 miles, the natural depth being in many cases from 3½ to 4 feet. The channel is divided at a number of points by islands forming sloughs and secondary channels behind them, through which a large portion of the volume of the flow is diverted, to the detriment of navigation.

The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, proceeding downstream from that city.

The first work for improvement began in 1872 and was continued for a number of years, as appropriations were made, the works consisting of dikes and dams of brush and stone, erected with a view to confining the low-water volume to one channel, and of revetments to hold and preserve the banks where necessary or advisable.

Under these appropriations work of this character was done at the following localities between the mouth of the Ohio and the mouth of the Illinois River, viz: Piasa Island, Alton Harbor, Sawyer Bend, St. Louis Harbor, Arsenal Island, Horsetail Bar, Carroll Island, Fort Chartres, Turkey Island, Kaskaskia Bend, Liberty Island, Devils Island, and in the vicinity of Cairo, Ill.

The present project is a continuation of the plan adopted in 1881, and contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles. The method employed is the building up of new banks out to the line desired from the solid matter brought down by the river, and which is collected by means of hurdles. The banks, both new and old, are revetted when necessary. Other means are also used occasionally for completing or hastening the depth required.

A hurdle, as the term is here used, is one of many silt-arresting devices that have been experimented upon in this country and elsewhere. The hurdles consist, essentially, of a row or of parallel rows of piling, the piles driven either singly or in clumps, the piling being connected lengthwise of the hurdle by wattling of fine brush or by curtains composed of brush and lodged against the upstream side of one of the rows of piles, the whole forming a permeable dike through which the silt-laden current can pass, though with greatly diminished velocity, resulting in deposits of silt above and below the hurdles.

These deposits are generally soon overgrown with willows or cottonwood, and after they arrive at sufficient height they can be revetted on their river fronts.

To guard against loss by scour of the piles, a broad, flexible mattress is first sunk on the line of the hurdle. Through this mat the piles and clumps of piles are driven.

During the past year the hurdles have been constructed of clumps of piles, three piles and upward to each clump. These piles are driven so that when their upper ends are drawn together by means of a wire rope they form a sort of pyramidal structure, the horizontal distances of the piles from each other at the surface of the river bed being 8 to 10 feet, depending mainly upon the depth of water.

The wire ropes are made on the work. They are composed of 14 to 18 strands of No. 14 galvanized iron wire. They are drawn taut by

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means of the pile-driver machinery. At each turn of the rope around the upper end of the clump of piles a spike is driven as an additional guard against the rope slipping, though the wire itself generally binds or cuts into the piling sufficiently to prevent any slip. This method of drawing the upper ends of the piles together appears to be better than the old one of bolting them.

The tops of the piles are generally at an elevation of 20 feet above extreme low water, excepting that in the curtain or wattling row the top of one pile of the clump is at an elevation of about 25 feet above that stage, in order to intercept drift at high stages and prevent it from crossing the line of hurdles and dragging the top of the latter with it.

The curtain or wattled row is braced by vertical diagonal braces heeled against a row of clumps spaced at such distances below as to make the angle of the braces about 45 degrees.

The heel of the braces is held by a clevis passing around one of the piles of the lower clump, with its pin through the brace. At top the brace is bolted to one or more of the piles in the upper clump.

The piling of the hurdle row is so spaced as to represent an equivalent of one pile to the linear foot of hurdle. The piles are driven by means of the hydraulic jet as well as by the hammer, the latter weighing 2,400 pounds, and sometimes by both combined.

The completed curtain, or the wattling, whichever may be used, is generally carried finally to a height of 20 feet above extreme low water. The mattress is from 60 to 135 feet in width, depending upon the depth of water and consequent length of piles, as well as upon liability of the bed to suffer from scour. It is fabricated upon floating ways, in place, by wattling brush upon poles spaced about 5 feet apart and in any length desired. Continuity is obtained by lapping the poles and fastening them together with spikes and wire. When additional strength is required wire cables are used across and in direction of the length of the mattress. The brush is spiked to the poles at the edges of the mattress and at other points, about one spike to every third pole. In sinking the mat a little less than 1 cubic yard of broken rock is required to a cord of brush.

The piles used in the hurdles run in lengths from 25 to 60 feet, and their average penetration in the bottom is about 15 feet. They are driven with the large end down.

At the shore end of the hurdle the bank is revetted for about 300 feet, of which 200 feet is below the axis of the hurdle.

In constructing the shore revetment a mat about 120 feet or more in width, its inner edge at the surface of standard low water, is sunk. The bank is then eventually graded to a slope of one-half and covered with riprap. Where necessary to grade the bank by artificial means, the grading is done by the hydraulic method, or by means of shovels, etc.

Since the adoption of this project work has been done at the following localities, by methods substantially as above described, viz: Piasa Island, Alton Harbor, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail Bar, Carroll Island, Twin Hollows, Pulltight and Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Cornice Island, Calico Island, Michaels Landing, Rush Tower, Fort Chartres, Crooks Landing, Turkey Island, Ste. Genevieve, Liberty Island, Hamburg, Minton Point, Cape Girardeau, Powers Island, Buffalo Island, and vicinity of Cairo.

Since last annual report work looking to the permanent improvement of the river has been carried on in the following localities: Arsenal Island, Twin Hollows, Illinois; Chesley Island, Missouri; Michaels

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Landing, Missouri; Osborne Fields, Illinois; Danby Landing, Missouri; Sycamore Landing, Illinois; Ste. Genevieve, opposite Chester, Ill.; Anchor Landing, Missouri; Wagner Landing, Illinois; Hamburg Slough, Devils Island, vicinity of Minton Point, Powers Island, and Buffalo Island.

Work in the nature of portable jetties and dredging for the temporary improvement of the channel was done in the following localities: Riverside, Harrisonville, Platin Rock, Grand Tower Bend, Seventy-six Landing, Juden Creek, and Buffalo Island.

Arsenal Island.—The head of this island is on the Illinois side of the river and nearly opposite the old arsenal grounds in St. Louis, Mo. Work has been done for the protection of this island from time to time between 1877 and 1885. The work of this latter year left the head protected with a rock revetment to about the 16-foot stage. For several years during high-water stages more or less erosion has taken place above this revetment. There being many other places where work was more urgently required than here to the full extent of the available funds, this revetment was not carried up to the full height of the bank. The high water of 1897, impinging against the head of the island with more than usual force, succeeded in getting behind the revetment and washed the bank away for about 900 feet. About 35 acres were washed from the head of the island. The tendency of the whole river seemed to be in that direction and to form a bar on the Missouri side. To remedy this it was necessary to reestablish the shore upon the Illinois side and to force the river over to the Missouri shore. Four hurdles aggregating 4,400 feet in length and about 1,700 feet apart were built out from the Illinois shore, as shown upon plate herewith. These serve to check the sediment carried by the river and cause a deposit in the locality which in time will be sufficiently high to be revetted and held permanently. This work was commenced September 17 and finished December 1.

During the high water of this year the main current was well over to the Missouri side with no tendency to erosion of the Illinois shore.

The material used and work done at this and other localities mentioned in this report are given in the tables devoted to these subjects to be found in the report of Assistant D. M. Currie, herewith. The expenses incurred are shown in the table of cost of works during the fiscal year.

Twin Hollows, Illinois (14 miles below St. Louis).—The revetment on the east side of the river in this locality was built in 1882 and years following. In 1894 some repairs were made. A decided tendency to erode above and behind this revetment during recent high waters has made it necessary to do considerable repair work here. On account of the limited supply of stone that could be made available for this work, the revetment for a distance of 4,077 feet was repaired only to a height of about 12 feet. The work was done between October 23 and November 26.

Chesley Island, Missouri (19 miles below St. Louis).—Prior to 1894 considerable work had been done at the head of this island and in the chute behind it. During that year some repairs had been made to the revetment. The high waters of recent years impinging upon the head of the island have worn it back into a concave shape, 150 feet in length by 50 feet in width, leaving the old-low-water protection mattress undisturbed. The new bank was revetted with stone November 27 to 30.

Michaels Landing (27 miles below St. Louis).—In my last annual report mention was made of the fact that a breach had been made in hurdle No. 1 of this series, and that hurdle No. 2 was in the process of construction behind it. This hurdle was completed July 19. The stone

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dike for the shore connection at the west end of this line and the revetment of Osborne Towhead at the outer end were completed July 31. A large quantity of drift having lodged against this line it was sunk, thus adding much to the strength of the hurdle. No attempt was made to close the large gap of 750 feet in hurdle No. 1. The checking of the water, drift, etc., by No. 2 seems to result in a shoaling of the water between the two hurdles.

Osborne Fields.—The river bank in this vicinity was revetted in 1893 and 1894, but never completed to high water. There has been a gradual erosion of the upper part of the bank, and as opportunity offers rock is placed upon this. Between August 16 and September 17 about 4,700 linear feet of this bank was covered with stone. Five hundred linear feet had eroded back of the low-water protection. This was regraded and covered with stone to a 10-foot stage.

Danby Landing, Missouri (39 miles below St. Louis).—In 1895 the eroding bank just below this landing, for a distance of 4,750 feet, was protected to the height of the 16-foot stage. Subsequent high waters graded the bank back and threatened to get back of the revetment. Between September 18 and October 5 repairs were made to this at the point where the most damage had been done. It will be necessary to carry this revetment to the top of the bank whenever funds can be spared for the purpose.

Sycamore Landing, Illinois (46 miles below St. Louis).—The revetment of the Illinois shore near Sycamore landing was begun in 1892. A protection mattress 5,500 feet in length was placed and stone carried above to the foot of the abrupt bank at the level of a 10-foot stage. The stone work was raised in the fall of 1893 to about the 18-foot stage for a distance of 3,750 feet down from the upper end. The lower end not being raised to the required height has been subjected to high water erosion. About 1,500 feet of this revetment was repaired between October 6 and 21. It will be necessary to do other work in this locality.

Turkey Island, Illinois (52 miles below St. Louis).—In 1895 a low-water protection mattress was placed on the west side of this island for a distance of 5,250 feet and high-water protection carried up to heights varying from 5 to 15 feet. Between October 21 and November 4 this was repaired and all parts brought up to at least a 10-foot stage. About 2,200 feet of bank was covered with stone in whole or in part. These repairs, like others that have been mentioned, were limited to what was urgently necessary, by reason of the fact that funds could be expended in relieving the immediate necessities of navigation to better advantage elsewhere.

Ste. Genevieve, Ill. (57 miles below St. Louis).—The work done in this locality is shown upon Plate III, which accompanied my last annual report. (See Chief of Engineers Report, 1897, p. 2014.) The work of the present year consisted of repairs to hurdles and revetment about the head of Moro Island. Hurdle No. 12 had been damaged some by heavy pour of water around its outer end. About 200 feet was broken down by this process. This was repaired and the head strengthened. The hurdle was further strengthened against a large accumulation of drift on its upper side.

In hurdle No. 15, which closes the chute to the east of the island, two gaps had been made by ice and high water of the preceding spring. The larger of these was 200 feet in width, with 25 to 30 feet depth at a 15-foot stage; the smaller was 60 feet wide with a maximum depth of 20 feet. These gaps were closed and the hurdle strengthened and put in good repair.

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The head of Moro Island and the west side for a distance of 5,700 feet had been revetted to a 10 foot stage in 1895. Subsequent high waters eroded the upper portion of this bank back so as to finally permit a large volume to pass between it and the low-water protection. The bank was carried away for a length of 3,000 feet. The maximum recession was 400 feet. To prevent further erosion and to restore the shore line to the old position and to the low-water protection, five short strong hurdles were built out, about 650 feet apart, extending from the bank to the old mattress, sloping between the ends down and out from the 25-foot level to the 15-foot level. The protections for the shore ends were made unusually strong, as the main current of the river strikes directly against this point. These hurdles were built between August 5 and September 28.

Ste. Genevieve, Mo.—At the lower end of the Ste. Genevieve reach and upon the Missouri side it was found necessary to hold a soft sand bank for a distance of 5,600 feet in order to preserve a proper alignment for the river channel. This was done by placing in front of it a good substantial low-water revetment and revetting the bank above this with stone to the height of the 10-foot stage. It is contemplated to extend this to the top of the bank as soon as it may be graded back by high water.

The lower end of this low-water mattress for a distance of 1,600 feet was made of lumber 1 inch thick, 4 to 6 inches wide, and 12 to 16 feet long. Lumber in this shape is easily handled and readily woven into a strong flexible mattress. The remainder of the mattress used in this protection was made of brush woven in the usual way and made very strong, to resist a very strong current found along this shore. Because of this current the work of making and sinking this mattress was very difficult. At one time 300 feet broke away from its moorings and was carried down the river. It was subsequently caught by one of the Government towboats and used at the works in Hamburg Chute, 60 miles below. Work in this locality was closed for the season October 22.

Chester, Ill. (73 miles below St. Louis).—The river and harbor act of June 3, 1896, contained a mandatory clause directing "that $30,000, or so much thereof as may be necessary, shall be expended in removing the bar in front of Chester, Ill., and protecting the west bank of the Mississippi River opposite Chester." In my last annual report I mentioned that in compliance with this law 3,310 feet of this bank had received a low-water protection and that the bank above the low-water line had been protected with stone to the height of the 10-foot stage, which was then the foot of the perpendicular portion of the bank. Subsequent high water having graded this bluff back, the revetment of the slope was continued up to the 20-foot stage. The work was done between October 23 and November 23. The full amount of the appropriation is now expended.

Anchor Landing (80 miles below St. Louis).—In this vicinity a second revetment was placed against the bank in 1895. The total length of mattress work was 7,250 feet and the stone work, or high-water revetment, was carried up to a 16-foot stage. The first revetment was made ineffective by the water getting in behind it.

Between the 22d and 29th of September repairs were made to this new revetment below the landing by taking stone from the old, which was then exposed. Later in the season, November 11 to 13, the stone work above the landing was repaired with stone brought from the quarry at Little Rock.

Wagner's Landing (84 miles below St. Louis).—This locality is the

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Liberty reach, in which, as mentioned in my last Annual Report, 6,850 feet of bank were reveted. The work done here during the season consists in repairs to this over a length of about 3,900 feet. The revetment was placed in as good a state of repair as time and funds available would admit.

Hamburg, Ill. (*120 miles below St. Louis*).—In this vicinity there was a reach of river difficult to navigate at low water. The water was divided into two channels by Hamburg Island, and where these joined below the island the width of the river bed is excessive. It is a region of troublesome sand bars and shoals. During the higher stages of the river the Illinois shore to the east of the island was subject to erosion and much valuable land was destroyed.

The first step looking toward the improvement of this reach for low-water navigation was evidently to close the chute between Hamburg Island and the Illinois shore. This was effected by the construction, during July and August, of two permeable hurdle dams. One, 2,860 feet in length, was located across the head of the chute; the second is 6,600 feet below this and about 700 feet below the caving bank on the Illinois shore. This is 1,225 feet in length.

In the first hurdle, designated No. 5 in the series projected for this reach, the piles were driven in three rows, 18 feet apart, with the piles of the middle row 6 feet apart, and in the other rows 12 feet apart for a length of 575 feet from the Illinois end. From this point the usual form of a double row of 3-pile staggered clumps was used to the bar line at the head of the island. A single row of 3-pile clumps was jetted across the dry bar to connect the head of the island with the double row of clumps.

The Illinois end of the hurdle was protected by a shore mattress 325 feet long, with revetment to the top of the bank, 22 feet above low water. The island end of the hurdle was well protected by reveting the bank with rock to prevent scour. Curtains were placed in front of the hurdle to a height of 8 feet above standard low water.

The second of these hurdles, No. 6, was constructed as a double row of 3-pile clumps driven after the construction of the foundation mattress 112 feet wide, reenforced in deep water near the island end by a third row of clumps. The clumps were brought into contact by a longitudinal stringer dropped between the clump rows, fastened by wire. The shore mattress at each end was 300 feet in length. The above-water revetment on the island end was placed the full length of the mattress and to the height of the bank. On the Illinois end, owing to the favorable position and hardness of the bank, the grading and revetment were carried only to 220 feet below the head of the shore mattress. Curtains were placed in front of the hurdle to the height of the 8-foot stage.

These two hurdles were finished on the 1st day of September.

The closing of this chute, even by these permeable structures, had a marked effect during the fall low-water season in increasing the depth of navigable water through the channel on the west side of the island.

The spring high water has caused extensive filling to take place about the head of the chute. A small break is reported in the middle of the upper hurdle and erosion has taken place around the island end of the lower. These are not regarded as serious and can be remedied at little cost. This work is shown upon Plate III herewith.

Devils Island (*124 miles below St. Louis*).—The reach of the river mentioned above extends down to the Devils Island country—a reach that has always given more or less trouble to steamboat men during

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low water. Considerable work has been done in this region in former years, commencing as far back as 1874. A dam was built, closing the chute between Picayune Island and the Illinois shore, and one closing the chute between this island and Devils Island. These have subserved the object for which they were built. The contraction works, formerly built near Minton Point and opposite Cape Girardeau, are now practically destroyed.

Rapid erosion has taken place of the newly formed land above the heads of these islands, and it was feared that if not stopped it would result in the destruction of the dams. To stop this erosion and at the same time put some sort of limit to the river in that direction, and get it into shape for passing the town of Cape Girardeau, it was deemed necessary to undertake work of considerable magnitude in this vicinity.

A hurdle 1,200 feet in length was built across the old head of Devils Island Chute. A mattress 200 feet wide protected this from scour, and extended with a width of 120 feet upstream 1,650 feet as a low-water protection to the shore, and down along the west side of Devils Island for a distance of 4,320 feet. The total length of this mattress was 7,070 feet.

Riprap-stone protection above low water extended to heights varying from 14 to 8 feet. This it is hoped will prevent further erosion in this locality until it can be returned to and placed in a more completed state.

At the lower end of the bend in which this revetment is placed it is necessary to contract the width of the river and throw the channel nearer to the Missouri shore. A very bad low-water crossing is here, on which it is desired to increase the depth of water.

With this object two hurdles, Nos. 9 and 11, were built. The upper one is 900 feet in length and the lower 1,200 feet. They are 2,000 feet apart. The upper hurdle, No. 9, having to withstand the pressure of large quantities of drift, is composed of three rows of 3-pile clumps, connected by longitudinal stringers, while the lower one, not being so much exposed, is composed of two rows of clumps. Both hurdles were suitably protected against excessive scour at their outer ends, and the bank at the shore ends riveted. Work in this vicinity was closed for the season September 20.

These two hurdles, being a part of the works designed for the improvement of the Mississippi River at Cape Girardeau and Minton Point, they were constructed in part from the unexpended appropriation of $22,500 made by the river and harbor act of August 5, 1886. This appropriation is now entirely exhausted.

Powers Island (145 miles below St. Louis).—In my last Annual Report mention was made that the work of improving the river in this vicinity had been commenced by the building of a strong hurdle dam in Doolans Slough, which separates Powers Island from the Missouri shore. This dam is successfully accomplishing the object for which it was constructed. Across the head of the slough and for some distance down there has been a large deposit of sediment, which has nearly closed the chute at low water. The improvement in navigation through this reach was very marked at low water last season.

The spring floods of 1897 caused a very heavy deposit of drift above the dam and some settlement of the rock revetment at its ends. The drift was sunk in place by putting a board mattress over it and weighting it down with stone, thus adding greatly to the strength of the dam. The revetment at the ends was repaired. The work was begun July 20 and finished August 10. The dam at last reports was in good condition.

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The width of the river below Commerce is excessive at almost all points, and will need more or less rectification and bank protection throughout the whole distance—35 miles—to the mouth of the Ohio.

At Commerce Island a hurdle is in process of construction, extending down the river across the heads of the chute and passing just outside of Allen Towhead. It is 2,850 feet in length, and in consequence of its exposed position made of great strength. This work was commenced May 11. At the end of the fiscal year it was nearly completed. Its location is shown on Plate IV.

Buffalo Island (154 miles below St. Louis).—In this vicinity there will be required extensive contraction works in order to properly rectify the river and insure good permanent low-water navigation. The first hurdle of the projected series was commenced March 23, 1898, and at the end of the fiscal year was practically finished. It is a strong hurdle dam designed to close the chute between the Illinois shore and Blackbird Island.

During a part of the last low-water season the main channel of the river was through this chute.

The dam is 3,050 feet long.

It is not expected that the new hurdles constructed during the year will be all that is required to rectify the river in their respective localities. They are only a commencement of a series which it will be necessary to construct in order to hold the river permanently. Their locations are so chosen as to give the best results with the money expended and minimize the amount of work to be done during next low-water season by the temporary expedients for improving the channel that are now at our command.

TEMPORARY EXPEDIENTS.

Work of a temporary character for the relief of navigation was done during the season in the following localities: Riverside, Harrisonville, Platin Rock, Stanton Towhead, Old River near Chester, Seventy-six Landing, Grand Tower Bend, Juden Creek, and Buffalo Island.

Riverside Landing is the most important shipping point in the Mississippi River between St. Louis and Cairo, by reason of the fact that it is the eastern terminus of the Mississippi River and Bonne Terre Railroad, from which its trains of loaded cars are transferred on large ferryboats to and from St. Louis. On the approach of the low-water season of last year a large shore bar began to develop above the incline at this place, which threatened to move down and close it out entirely. To prevent this, dredge No. 2 was set at work to keep a channel open inshore through this bar.

At Bushberg, a short distance above Riverside, the main channel is deflected from the Missouri across to the Illinois shore and returns again below Riverside. Within a distance of 6 miles the river channel in this vicinity makes four crossings from one side to the other.

With the view to increasing the volume of water through the cut made by the dredge, a portable jetty, 1,100 feet in length, was constructed on the upper side of the bar, inclining outward into the main channel. The towboat *Gen. Abbot* gave occasional assistance with her wheel at the lower end of this cut.

When the dredging was commenced, August 21, the soundings along the line of the proposed cut indicated a minimum depth of 3½ feet with the water at a 10-foot stage on the St. Louis gauge. When work was discontinued, October 12, there was a cut 100 feet wide and nearly 4,000

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feet long with a minimum depth of 4 feet with the water at a 3-foot stage on the St. Louis gauge.

Although this cut was not used by the steamers passing up and down the river the results obtained were satisfactory in so far that the landing at the Riverside incline was kept open and available during the whole season.

Dredge No. 2 worked a few days during October at the crossing near Riverside, removing a reef that had moved down with the channel. It was then taken into "Old River." This was the bed of the river near Chester, Ill., prior to the Kaskaskia cut-off. It makes a fine winter harbor for the Government floating plant, and has been used as such for the past three winters. The entrance to this is gradually shoaling up. Last fall it was necessary to dredge a channel through the shoal at the lower end in order to get the boats in. This was done by dredge No. 2 during the month of November. A cut was made 120 feet wide, 3 feet deep, and 1,750 feet long. The work closed December 4, 1897.

The material taken from this was silt and stiff clay, mixed with sand. It was deposited through the discharge pipes at a distance of 500 feet from the cut.

A description of this dredge is given in my last annual report. The machinery during this last season worked in a very satisfactory manner and fully up to expectations. No special effort was made to ascertain the amount of material removed. If such had been done the results could only have been approximated. The cost per cubic yard can not therefore be given.

Jet dredge No. 1.—This dredge was in commission from August 20 to the end of November and did good service jetting sand reefs and improving the channel at Stantons Towhead, Grand Tower Bend, and Buffalo Island. In its work the dredge was materially assisted by the towboats *Abbot* and *Casey*. These boats have each been provided with two heavy spuds—one on each side of the bow—which can be let down when the boat is on a bar or reef. When the wheel is worked with the boat thus anchored, a strong current is induced which carries the sand down stream. When either of these boats could be spared from their regular towing work they were used in connection with dredge No. 1 to deepen the channel through shoals.

Portable jetties.—As the river began to approach its low stage the necessity for concentrating the water at some of the shoal places became apparent. Before the season was over jetties had been built in the following localities: Riverside, Harrisonville, upper and lower crossings; Platin Rock, Seventy-six Landing, Juden Creek, and Buffalo Island.

The jetties varied in length from 450 to 2,230 feet. The total length built and removed during the season was 9,345 linear feet. The jetty party took the field during the latter part of August and was withdrawn early in December. It was in the field ninety-seven days, of which thirty-nine were employed in construction, twenty-three in removal, nineteen in towage from place to place, and sixteen were lost (Sundays, rain, etc.).

The cost of putting this length of jetty out and replacing it in store was but $3 per linear foot. This includes the proportional expenses for plant, repairs, deterioration, towage, office, engineer depot, etc.

The jetties materially improved and maintained the channel at each of the crossings where they were placed, giving a navigable depth of 5 feet or more, although the river reached a stage of 1.2 feet below the standard low water.

Hydraulic dredges Nos. 3 and 4.—In my last annual report a descrip-

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tion is given of these two dredges. At that time they were under construction. The contract was entered into with The Bucyrus Company, South Milwaukee, Wis., March 17, 1897, and by its terms both dredges should have been completed on or before October 10, 1897. This time came and neither one of them was ready for delivery. The time for delivery was extended to April 20, 1898. Dredge No. 3 was delivered January 31, 1898, and dredge No. 4 was delivered April 15, 1898. Both these dredges were subjected to an efficiency test of sufficient duration to fully demonstrate that all their machinery and parts were equal to the requirements of the specifications, and that in respect to workmanship and material the terms of the contract were fully complied with. During these efficiency tests it was shown that one battery of these boilers (there are six boilers on each dredge) could, if necessary, be made to furnish all the steam required for both pumps. With 115 pounds of steam each engine developed 305 horsepower, driving the pump disks at 200 revolutions per minute, and delivering the material through 500 feet of discharge pipe. No barge measurements for capacity were attempted, but from cross sections made ahead of the nozzles and in rear of them, it was estimated that at least 1,200 cubic yards of sand per hour were going through the pumps.

During the test of dredge No. 3, and while the nozzles were being purposely crowded ahead with the discharge pipes, carrying about 30 per cent of sand, both pipe lines turned completely over. The water in the river was running at a rate of about 4 miles per hour.

The primary cause of this accident was water in some of the pontoons, which ran to the lowest corner and brought it below the water surface, where it was caught by the swift current, when one pontoon started over and the whole line had to go. The lines were righted with some little trouble, and to prevent a recurrence of the accident, lashed together during the remaining time of the test.

It is not expected that dredging will be done in a current so swift as 4 miles an hour, or that the pipes will be often loaded so heavily with sand. To provide against a possibility of this kind, however, steps have been taken to have all the pontoons widened by putting upon the sides a triangular-shaped piece, rounded at the outer angle. This is being done at the engineer depot by Government employees.

A number of other slight alterations and additions are being made to these dredges, which were not foreseen and provided for in the contract for their construction, all of which will add greatly to economy and facility of operation.

The utility of the swivel joint in the discharge pipes where they leave the dredge, and the system of pontoon supports so arranged as to swing under the pipes was fully demonstrated during the test of dredge No. 4. By properly adjusting the pontoons to the current, which was about 3 miles per hour, no difficulty was experienced in throwing the discharge pipes 670 feet apart at their outer ends without the aid of any other force than that of the river current. With experience in handling, this distance can be increased to 800 feet, or, in other words, the material can be delivered by this means 400 feet on either side of the dredged channel.

This device is certainly a great step in the direction of economy, both of time and money in these dredging operations. By it the pipe lines can be easily swung out of the way of passing river craft and back into position again without stopping the dredge pumps. Each line of pontoons is maneuvered by two wire cables that pass along their sides and to each of which they are made fast at one point. The action is like the well-known boom rudders used by loggers to throw booms

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across narrow streams for the purpose of catching timber as it floats down.

Model barges.—During the year eighteen model barges were obtained by contract for use upon the works. These barges were of the same dimensions and capacity as those heretofore in use. Contract was entered into with David S. Barmore, Madison, Ind., to furnish twelve of these and with the Cincinnati Marine Railway Company, Cincinnati, Ohio, to furnish six.

By the terms of the contracts the barges should have been finished and delivered on or before May 15, 1898. Owing to high water in the Ohio River the contractors were unable to do this. The time for completing Mr. Barmore's contract was extended to June 15, 1898, and for the Cincinnati Marine Railway Company's contract to July 14, 1898.

At the end of the fiscal year the construction of all the barges was finished, but two from each of the contractors remained to be delivered.

Under existing contracts 502,018 linear feet of first-class piles and 460,992 linear feet of second-class piles were paid for.

There were 32,981.6 cubic yards of stone purchased during the year under existing contracts.

The two steel-hulled hydraulic dredges, Nos. 3 and 4, the piles and the stone above mentioned, were paid for from the $325,000 appropriated by the deficiency act of July 19, 1897, and authorized to be contracted for by the river and harbor act of June 3, 1896.

During the year 81,978.4 cubic yards of stone were obtained by hired labor from Government quarries at Little Rock, Mo., at an average cost of 58.2 cents per yard loaded on barges. In addition to these amounts 10,571.1 cubic yards were purchased in open market.

There were also obtained by hired labor 30,522 cords of brush, at an average cost of $1.30 per cord loaded on barges.

The plant pertaining to this work was kept in good state of repairs during the year and rendered efficient service.

In consequence of want of barges at times during the season of active work the cost of brush and stone was much higher than it would otherwise have been. The 18 new barges now being delivered will remedy this to a certain extent during the coming season.

The dredging operations during the low-water season, when revetment and other work is in progress, will tax the capacity of our towboats and tenders beyond their limit. It will be necessary during the coming season to construct at least one new towboat and two tenders.

Mr. D. M. Currie has continued to discharge the duties of principal assistant engineer upon the works, and Mr. William S. Mitchell and Mr. John O. Holman in charge of the parties in the field. The procuring of brush and quarrying of stone by hired labor was done by parties in charge of Mr. E. D. Libby, assistant engineer. The engineer depot, at which a large part of the supplies for the work of the district is assembled and distributed, and repairs to tools and additions and repairs to floating plant are made has been continued in charge of Supt. C. D. Lamb. All these gentlemen, together with the office force connected with the work, have satisfactorily discharged their several duties. For further details concerning the operations of the year reference is invited to appendixes herewith.

ESTIMATES.

The original estimate of the cost of the improvement of the Mississippi River between the mouth of the Ohio and the mouth of the Missouri River, as revised in 1883, is $16,397,500.

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The aggregate amount of funds appropriated and made available for this work to June 30, 1898, is $8,178,333.32.

The total appropriations to date amount to $8,358,333.32. Of this amount $180,000 was allotted by acts and projects for improvement between the Illinois and the Missouri rivers, including Alton Harbor, leaving a balance of $8,178,333.32, as stated above, to be applied to the project for the general improvement of the river between the mouth of the Missouri and the mouth of the Ohio River.

Of this amount, there was on hand June 30, 1898, an available balance of $179,266.35, exclusive of outstanding liabilities. The amount that has been expended upon the project to this date is, therefore, $7,999,066.97.

The amount expended during the fiscal year ending June 30, 1898, is $868,793.96.

The river and harbor act approved June 3, 1896, provides:

That any balance of former appropriations now available and the money hereby appropriated and authorized to be expended for the said section of said river between the mouth of the Missouri River and the mouth of the Ohio River, or so much thereof as may be necessary, shall be expended in the construction of suitable dredge boats, portable jetties, and other suitable appliances, and in the maintenance and operation of the same, with the view of ultimately obtaining and maintaining a navigable channel from St. Louis to Cairo not less than 250 feet in width and 9 feet in depth at all periods of the year, except when navigation is closed by ice.

In the $7,999,066.97 above mentioned, is included what has been expended for dredge plant, portable jetties, and appliances for temporary improvement of the channel, and for operating the same. This amounts to about $431,599.94. Of this, $287,382.49 was expended during this fiscal year. The present value of the plant pertaining to this temporary work is now estimated at approximately $287,290.45.

The available balance includes the unexpended balances from special allotments made by Congress, as follows:

For bank protection at Cairo, Ill., act of July 5, 1884	$8,600
For bank protection on east side of Mississippi River opposite to mouth of Missouri River, act June 3, 1896	50,000
Total	58,600

In view of facts connected with this item of $50,000 appropriated for the bank protection on the east side of the Mississippi River, to be expended at the discretion of the Secretary of War, as set forth in my letter of May 20, 1897, to the Chief of Engineers, and other papers connected therewith, I respectfully recommend that such action be taken in the premises as will make the sum available for any purpose for which the appropriation from which it was withdrawn was available.

As the matter now stands this $50,000 is tied up indefinitely, doing no good, while the general improvement of the river is greatly in need of funds to carry it forward.

The balance of the estimate for the original project not appropriated *June 30, 1898*, is $8,219,166.68.

It is estimated that the sum of $800,000 can be profitably expended *during the fiscal year* ending June 30, 1900, in the work of the original *project and in* the temporary work required by the river and harbor *act of June 3, 1896.*

This work is in the collection district of New Orleans. The nearest port of entry *is St. Louis, Mo., at* which place the customs collected during the fiscal year ending *June 30, 1898, amounted to* $1,000,632.43. The amount of internal revenue collected *was $8,394,365.65.*

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Money statement.

July 1, 1897, balance unexpended		$782,518.93
Amount appropriated by deficiency act approved July 19, 1897		325,000.00
		1,107,518.93
June 30, 1898, amount expended during fiscal year		868,793.96
July 1, 1898, balance unexpended		238,724.97
July 1, 1898, outstanding liabilities	$3,223.64	
July 1, 1898, amount covered by uncompleted contracts	56,234.98	
		59,458.62
July 1, 1898, balance available		*179,266.35
Amount (estimated) required for completion of existing project		8,219,166.68
Amount that can be profitably expended in fiscal year ending June 30, 1900		800,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

List of appropriations.

By act of—		By act of—	
June 10, 1872	$100,000.00	August 11, 1888	$300,000.00
March 3, 1873	200,000.00	September 19, 1890	400,000.00
June 23, 1874	200,000.00	July 13, 1892	525,000.00
March 3, 1875	200,000.00	March 3, 1893	658,333.33
August 14, 1876	200,000.00	August 18, 1894	758,333.33
June 18, 1878	240,000.00	March 2, 1895	758,333.33
March 3, 1879	200,000.00	June 3, 1896	275,000.00
June 14, 1880	250,000.00	June 4, 1897	673,333.33
March 3, 1881	600,000.00	July 19, 1897	325,000.00
August 2, 1882	600,000.00		
July 5, 1884	520,000.00	Total	8,358,333.32
August 5, 1886	375,000.00		

Abstract of proposals for model barges for improving Mississippi River between mouths of Ohio and Missouri rivers, received in response to advertisement of August 2, 1897, and opened September 1, 1897, by Maj. Thos. H. Handbury, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Number bid on.	Price each.	Amount.	Remarks.
1	Ed. J. Howard, Jeffersonville, Ind	6	$4,000	$24,000	
2	Cincinnati Marine Railway Co., Cincinnati, Ohio.	6	3,597	21,582	
3	Elizabeth Marine Ways Co., Elizabeth, Pa	12	5,975	71,700	
4	David S. Barmore, Madison, Ind	6 to 12	3,800	22,800 to 45,600	
5	Godfrey Marine Ways Co., Lyons, Iowa	2	3,578	7,156	Bid defective.

Acceptance recommended of bid No. 2 for 6 barges.
Acceptance recommended of bid No. 4 for 12 barges.

* Of this balance special allotments have been made by Congress, as follows:

Bank protection at Cairo, Ill., act of July 5, 1884 (balance)	$8,600
Bank protection on east side Mississippi River opposite mouth of Missouri River, act of June 3, 1896	50,000
Total	58,600

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List of contracts in force.

Articles.	Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration.
4,000 piles, more or less	H. A. Russell	Apr. 14, 1897	15 days after notice.	When delivery is completed.
20,000 cubic yards stone	Earle E. Burke	May 5, 1897	....do	
12,000 piles, more or less	John H. Crowder	May 6, 1897	....do	
6 model barges	Cincinnati Marine Railway Co.	Oct. 14, 1897	10 days after notice.	May 15, 1898.
12 model barges	David S. Barmore	Sept. 30, 1897	....do	Do.

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the years 1894, 1895, 1896, and 1897.

Articles.	1894.	1895.	1896.	1897.
RECEIPTS.	Tons.	Tons.	Tons.	Tons.
Barbed wire, ores, and metals (pig and manufactured)	22,942	24,759	30,395	25,449
Cement	7,718	11,026	9,342	4,747
Coal and coke	26,625	18,785	50,820	22,490
Cotton and cotton products	2,249	1,588	2,822	1,803
Groceries and dairy products	20,407	16,481	14,449	18,311
Hay, seed, grain, flour, meal, etc	77,489	67,586	55,148	34,094
Live stock and products	14,820	20,623	27,474	24,158
Lumber	228,087	189,721	173,891	103,165
Merchandise and sundries	175,633	138,317	300,741	327,993
Vegetables and fruits	6,133	19,321	6,383	13,513
White lead, oils, etc	48	63	44	90
Wines and liquors	79	75	50	30
Wool	280	490	206	232
Total	583,510	508,830	671,765	576,670
SHIPMENTS.				
Barbed wire, ores, and metals (pig and manufactured)	2,066	2,873	2,277	2,513
Cement				
Coal and coke	76,055	47,402	99,558	117,280
Cotton and cotton products	16	11	10	1,776
Groceries and dairy products	9,479	11,645	9,919	9,492
Hay, seed, grain, flour, meal, etc	148,477	123,734	350,180	230,221
Live stock and products	9,955	10,305	10,233	9,190
Lumber	3,135	4,452	5,457	4,480
Merchandise and sundries	105,261	94,459	85,213	84,895
Vegetables and fruits	1,878	3,273	2,076	2,810
White lead, oils, etc	1,356	1,828	2,575	1,975
Wines and liquors	5,383	3,852	4,911	4,721
Wool	19	21	1	12
Total	363,080	303,355	572,410	469,365

Transferred by ferries across the river at St. Louis.

	Tons.		Tons.
1894	2,826,859	1896	2,529,786
1895	2,809,791	1897	3,042,674

Shipments down the river from landings between St. Louis and Cairo during the years 1894, 1895, 1896, and 1897.

Grain, including flour, meal, etc., and coal:

	Tons.
1894	57,120
1895	26,715
1896	75,513
1897	69,815

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RECAPITULATION.

	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	946,590	812,185	1,244,175	1,046,035
Transferred by ferries at St. Louis	2,826,859	2,809,791	2,529,786	3,042,674
Shipped from landings between St. Louis and Cairo	57,120	26,715	75,513	69,815
Total	3,830,569	3,648,691	3,849,474	4,158,524

List of steam-power boats that arrived at St. Louis during the year 1897.

Size of boats.	Draft.	Boats.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 6	87	1,067
Between 500 and 1,000 gross tons	4 to 7.6	16	471
Over 1,000 gross tons	6 to 9.5	7	488
Total		110	2,026

List of barges and scows that arrived at St. Louis during the year 1897.

Size of boats.	Draft.	Barges and scows.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 7.5	194	607
Between 500 and 1,000 gross tons	5.2 to 8	23	72
Over 1,000 gross tons	5.3 to 9	59	204
Total		276	883

List of steamers and barges permanently enrolled and licensed at the port of St. Louis on the 31st day of December, 1897.

	Number of vessels.	Gross tonnage.	Net tonnage.
Permanently enrolled:			
Steamers (wood)	85	30,632.54	29,161.63
Steamers (iron and steel)	8	3,174.57	2,733.90
Barges	89	81,714.82	81,623.98
Gasoline vessels	3	87.79	81.17
Permanently licensed:			
Steamers under 20 tons (wood)	7	82.43	66.71
Steamers under 20 tons (iron)	1	26.92	13.46
Barges under 20 tons	3	34.73	34.73
Gasoline vessels under 20 tons	4	53.47	42.91
Yachts under 20 tons	3	30.23	25.77
Total	203	115,837.50	113,784.26

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CONSTRUCTION.

Cost of works during fiscal year ending June 30, 1898.

Labor, plant, and material.	Arsenal Island, hurdles.	Twin Hollows, east side, protection.	Chesley Island, Mo., protection.	Michaels, hurdles.	Rush Tower, protection.	Danbya, protection.	Fort Chartres, east side, protection.
Labor, superintendence, etc.	$17,879.68	$1,237.34	$235.25	$6,303.60	$1,671.22	$923.25	$832.29
United States Engineer Office	928.17	51.58	51.58	309.48	103.16	51.58	51.58
General expense	809.49	44.92	44.92	269.52	89.84	44.92	44.92
Plant	9,383.44	605.58	195.58	3,264.48	924.16	482.58	441.58
Material	1,391.04	77.28	77.28	463.68	154.56	77.28	77.28
Surveys, etc	262.26	14.57	14.57	87.42	29.14	14.57	14.57
Steamer Gen. Gillmore	30.00	.....	.....	198.00	78.00	.....	.....
Steamer Gen. T. L. Casey	481.11	.....	.....	276.50	.....	.....	.....
Steamer Gen. H. L. Abbot	286.01	.....	.....	108.22	.....	.....	.....
Steam tenders	440.55	19.80	.....	79.20	.....	.....	19.80
Quarter barges	343.80	15.28	3.82	7.64	19.10	7.64	7.64
Quarter boats	161.50	61.20	6.80	115.60	56.10	32.30	27.20
Office and survey boats	45.21	5.48	1.37	23.29	6.85	2.74	2.74
Pile drivers	2,229.14	.....	.....	667.48	.....	31.57	63.14
Small boats	1,955.39	68.12	4.36	746.65	122.63	52.32	45.78
Portable quarters	59.40	2.64	.....	.....	3.30	1.32	1.32
Tools, etc	877.92	47.20	9.44	302.08	103.84	37.76	47.20
Boarding outfit	644.49	34.65	6.93	221.76	76.23	26.82	34.65
Subsistence	4,540.73	387.08	63.56	1,814.00	535.18	300.64	231.57
Brush	8,309.56	.....	.....	1,675.24	.....	.....	.....
Piles	16,663.82	.....	.....	6,143.52	.....	.....	.....
Stone	5,851.17	3,068.75	586.09	4,773.37	5,658.82	1,821.30	2,392.26
Rope	136.17	8.11	.....	8.11	8.11	8.11	8.11
Wire	440.10	.....	.....	91.58	.....	.....	.....
Iron	3.84	.....	.....	.83	.....	.....	.....
Nails	45.20	.....	.....	21.96	.....	.....	.....
Spikes	110.50	.....	.....	56.00	.....	.....	.....
Lumber	73.77	10.65	.....	508.17	4.25	.....	.....
Oakum	6.00	.....	.....	.....	.....	.....	.....
Coal	898.24	32.00	4.00	416.00	18.00	28.00	36.00
Coal, blacksmiths'	.51	.....	.....	.17	.....	.....	.....
Material, miscellaneous	139.94	16.30	2.50	91.91	21.47	4.20	4.00
Total	75,428.15	5,808.53	1,308.05	29,045.76	9,683.96	3,948.90	4,433.63

Labor, plant, and material.	Turkey Island, protection.	Ste. Genevieve, Ill., hurdles.	Ste. Genevieve, Mo., hurdles.	Ste. Genevieve, Mo., protection.	Moro Island, protection.	Chester, Mo., protection.	Liberty Island (Anchor Landing), protection.
Labor, superintendence, etc.	$952.17	$6,157.16	$1,620.57	$9,970.10	$7,238.99	$1,596.28	$1,122.48
United States Engineer Office	51.58	309.48	103.16	515.80	361.06	103.16	51.58
General expense	44.92	269.52	89.84	449.20	314.44	89.84	44.92
Plant	523.58	3,223.48	883.16	5,235.80	3,747.06	227.16	564.58
Material	77.28	463.68	154.56	772.80	540.96	154.56	77.28
Surveys, etc	14.57	87.42	29.14	145.70	101.99	29.14	14.57
Steamer Gen. Gillmore	.....	.....	.....	426.00	234.00	.....	.....
Steamer Gen. T. L. Casey	.....	.....	.....	221.20	176.96	.....	.....
Steamer Gen. H. L. Abbot	.....	.....	.....	.....	486.99	.....	.....
Steam tenders	.....	193.05	29.70	198.00	168.30	.....	.....
Quarter barges	7.64	34.38	7.64	68.76	45.84	15.28	7.64
Quarter boats	22.10	81.60	32.30	151.30	103.70	39.10	20.40
Office and survey boats	2.74	34.25	2.74	24.66	16.44	5.48	2.74
Pile drivers	49.61	622.38	157.85	90.22	649.44	45.10	.....
Small boats	47.96	645.28	198.38	1,111.80	941.22	82.84	109.00
Portable quarters	.66	6.66	1.32	11.88	7.92	2.64	1.32
Tools, etc	66.08	264.32	75.52	585.28	377.60	94.40	66.08
Boarding outfit	42.51	194.04	62.37	429.66	277.20	69.30	42.51
Subsistence	296.83	1,626.50	471.30	3,434.78	2,430.54	552.34	365.47
Brush	.....	2,113.98	1,270.00	6,568.98	3,735.27	.....	.....
Piles	.....	6,132.74	1,470.13	217.12	4,807.09	.....	.....
Stone	2,378.22	1,651.57	389.22	9,920.04	4,715.10	4,140.24	450.84
Rope	8.11	72.99	8.11	421.72	56.77	8.11	.....
Wire	.....	140.80	58.46	692.60	296.87	.....	.....
Iron	.....	1.67	.....	.83	.....	.....	.....
Nails	.....	12.81	12.81	105.28	29.28	.....	.....
Spikes	.....	65.80	40.00	123.50	123.20	.....	.....
Lumber	.....	10.65	.....	1,653.74	10.65	.....	.....
Oakum	.....	.....	.....	3.00	.....	.....	.....
Coal	28.00	483.76	88.00	272.00	596.16	20.00	12.00
Coal, blacksmiths'	.....	.34	.....	.....	.17	.....	.....
Material, miscellaneous	9.40	138.25	29.80	83.45	48.46	8.95	5.50
Total	4,623.96	25,038.56	7,286.08	43,914.15	32,639.67	7,283.92	2,958.91

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Cost of works during fiscal year ending June 30, 1898—Continued.

Labor, plant, and material.	Liberty Island (Wagner landing), protection.	Hamburg, hurdles.	Devils Island, hurdles.	Devils Island (Cape Girardeau), hurdles.	Devils Island, protection.	Power Island, protection.
Labor, superintendence, etc...	$1,669.60	$15,876.78	$2,323.14	$10,971.70	$10,600.51	$1,619.25
United States Engineer Office.	103.16	825.28	103.16	515.80	515.80	103.16
General expense	89.84	718.72	89.84	449.20	449.20	89.84
Plant	924.16	8,295.28	1,170.16	5,646.80	5,481.80	883.16
Material	154.56	1,236.48	154.56	772.80	772.80	154.56
Surveys, etc	29.14	233.12	29.14	145.70	145.70	29.14
Steamer Gen. Gillmore	.....	588.00	.....	.....	.....	.....
Steamer Gen. T. L. Casey	.....	398.16	.....	.....	27.65	82.95
Steamer Gen. H. L. Abbot	.....	587.48	.....	.....	.....	417.42
Steam tenders	.....	410.85	39.60	326.70	252.45	.....
Barges	.....	56.60	.....	5.66	.....	.....
Quarter barges	11.46	305.60	64.94	171.90	324.70	3.82
Quarter boats	34.00	206.24	32.30	161.50	187.00	39.10
Office and survey boats	4.11	63.02	10.96	21.92	83.57	1.37
Pile drivers	.....	1,217.70	329.23	874.94	.....	85.69
Small boats	74.12	1,984.25	362.97	1,559.25	610.40	134.62
Portable quarters	1.98	197.34	39.60	103.62	208.22	.66
Tools, etc	113.28	698.56	56.64	217.12	434.24	94.40
Boarding outfit	83.16	512.82	41.58	159.39	314.78	69.30
Subsistence	558.06	4,576.96	988.68	2,604.05	3,660.10	485.60
Brush	.....	7,054.08	948.75	4,121.54	8,920.23	.....
Piles	.....	12,565.44	2,967.94	9,408.23	.....	.....
Stone	3,340.74	6,301.54	335.64	3,763.58	12,286.40	2,516.91
Rope	8.11	89.21	56.77	81.10	415.88	24.33
Wire	.....	520.70	57.60	307.80	543.81	61.85
Iron	.....	3.42	.....	5.18	.....	.....
Nails	.....	69.59	42.09	47.58	148.23	45.75
Spikes	.....	286.00	32.00	72.00	148.00	20.00
Bolts, screw	.....	67.66	.....	.....	.....	.....
Clevises	.....	147.00	.....	.....	.....	.....
Lumber	.....	59.71	12.70	42.62	86.23	443.86
Oakum	.....	1.50	.....	4.50	3.00	.....
Coal	22.00	998.00	102.80	688.00	192.00	56.00
Coal, blacksmiths'	.....	.34	.....	.51	.....	.....
Material, miscellaneous	5.30	389.86	33.09	264.77	231.49	42.52
Total	7,226.78	67,493.29	10,425.88	43,515.46	46,994.19	7,505.26

Labor, plant, and material.	Commerce Island, Mo., hurdles.	Buffalo Island, Mo., hurdles.	Beach Ridge, Ill., protection.	Jetties.	Dredging.	Total.
Labor, superintendence, etc...	$8,864.56	$19,932.11	$10,147.49	$8,385.93	.....	$148,131.45
United States Engineer Office.	1,543.70	3,430.60	995.60	412.64	$567.38	12,159.23
General expense	1,923.05	4,273.43	1,124.20	359.36	494.12	12,712.01
Plant	3,608.00	8,200.00	4,838.61	908.64	1,249.88	70,908.71
Material	927.18	2,060.40	875.82	618.24	850.72	13,137.64
Surveys, etc	.....	.....	86.93	.....	.....	1,558.50
Steamer Gen. Gillmore	.....	.....	612.00	953.75	.....	3,119.75
Steamer Gen. T. L. Casey	.....	139.23	478.03	1,117.06	1,119.65	4,518.50
Steamer Gen. H. L. Abbot	.....	2,106.80	201.52	1,870.66	3,534.83	9,599.93
Dredge No. 1	.....	.....	.....	.....	11,219.88	11,219.88
Dredge No. 2	.....	.....	.....	.....	15,295.84	15,295.84
Steam tenders	350.00	734.30	84.72	386.10	.....	3,733.12
Barges	.....	.....	.....	491.00	.....	553.26
Quarter barges	20.67	68.37	47.10	76.40	.....	1,687.06
Quarter boats	1,692.00	4,018.50	1,150.70	158.10	.....	8,590.64
Office and survey boats	44.00	155.52	34.33	27.40	.....	622.93
Pile drivers	482.00	1,109.61	153.34	1,560.46	.....	10,427.90
Small boats	872.59	2,398.71	772.85	710.14	.....	15,611.63
Portable quarters	16.76	62.01	16.68	13.20	.....	760.45
Jetty gates	.....	.....	.....	7,927.99	.....	7,927.99
Tools, etc	240.07	471.82	567.61	343.60	.....	6,192.06
Boarding outfit	219.72	431.84	435.09	275.52	.....	4,706.32
Subsistence	2,408.51	6,689.58	2,771.59	2,269.99	.....	44,113.64
Brush	3,005.70	4,736.20	955.39	.....	.....	53,414.92
Piles	10,747.57	17,660.96	1,120.67	489.23	.....	90,394.76
Stone	4,883.52	14,436.87	14,605.21	.....	.....	110,267.04
Rope	56.00	160.00	152.99	162.20	.....	1,959.12
Wire	604.20	640.30	1,022.50	51.75	.....	5,530.92
Iron	1.17	1.78	.....	1.25	.....	19.97
Nails	69.20	89.13	244.21	1.83	.....	984.90
Spikes	89.00	96.00	109.80	16.00	.....	1,337.80
Bolts, screw	.....	.....	.....	.....	.....	67.66

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Cost of works during fiscal year ending June 30, 1898—Continued.

Labor, plant, and material.	Commerce Island, Mo., hurdles.	Buffalo Island, Mo., hurdles.	Beach Ridge, Ill., protection.	Jetties.	Dredging.	Total.
Clevises						$147.00
Lumber	$2,142.41	$2,172.03	$7,130.94	$767.16		15,079.54
Oakum						18.00
Coal	1,020.92	1,436.79	158.57	637.60		8,244.84
Coal, blacksmiths'	.17	.18		.51		2.90
Material, miscellaneous	100.00	310.15	66.60	144.70		2,192.61
Total	45,932.67	98,023.22	50,961.09	31,138.41	$34,332.30	696,950.78

Total cost of works to June 30, 1898.

Name of work.	Expended—		Total.
	Prior to July 1, 1897.	During year 1897–98.	
Sawyer Bend, protection	$96,803.63		$96,803.63
Venice dikes	36,341.85		36,341.85
St. Louis Harbor	144,048.94		144,048.94
Arsenal Island, protection	42,599.06		42,599.06
Arsenal Island, hurdles		$75,428.15	75,428.15
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite St. Louis	58,455.54		58,455.54
Horsetail Bar, dikes 1 to 5, inclusive	225,066.31		225,066.31
Horsetail Bar, training wall	81,253.28		81,253.28
Horsetail Bar, hurdles	618,447.68		618,447.68
Horsetail Bar, bank protection	68,632.42		68,632.42
Carrolls Island, hurdles	40,343.98		40,343.98
Twin Hollows, west side, hurdles	315,611.64		315,611.64
Twin Hollows, west side, bank protection	56,567.66		56,567.66
Twin Hollows, east side, bank protection	129,435.57	5,808.53	135,244.10
Pulltight, hurdles	519,185.10		519,185.10
Pulltight, bank protection	1,818.23		1,818.23
Beards Island, primary hurdle	7,166.24		7,166.24
Beards Island, bank protection	84,258.76		84,258.76
Chesley Island, hurdles	27,808.61		27,808.61
Chesley Island, bank protection	73,916.55	1,308.05	75,224.60
Jim Smiths, hurdles	365,803.33		365,803.33
Jim Smiths, bank protection	7,569.58		7,569.58
Sulphur Springs, hurdles	371,350.31		371,350.31
Foster Island, protection	46,637.49		46,637.49
Lucas, hurdles	272,802.82		272,802.82
Cornice Island, hurdles	63,545.27		63,545.27
Rush Tower, hurdles	218,267.90		218,267.90
Michaels, hurdles	161,166.20	29,045.76	190,211.96
Rush Tower, bank protection	86,448.74	9,683.96	96,132.70
Danbys, bank protection	25,190.80	3,948.90	29,139.70
Fort Chartres, dam	36,812.86		36,812.86
Fort Chartres, west side, hurdles	225,883.99		225,883.99
Fort Chartres, west side, bank protection	19,458.12		19,458.12
Bruce Island, bank protection	3,971.99		3,971.99
Fort Chartres, east side, bank protection	39,846.88	4,433.63	44,280.51
Crooks	39,829.94		39,829.94
Turkey Island, dam	24,463.85		24,463.85
Turkey Island, bank protection	28,829.33	4,623.96	33,453.29
Ste. Genevieve, Ill., hurdles	270,621.93	25,038.56	295,660.49
Ste. Genevieve, Ill., bank protection	26,189.35		26,189.35
Ste. Genevieve, Mo., hurdles	257,055.95	7,286.08	264,342.03
Ste. Genevieve, Mo., bank protection	2,063.91	43,914.15	45,978.06
Moro Island, bank protection	1,045.26	32,639.67	33,684.93
Kaskaskia, bank protection	66,465.62		66,465.62
Chester, Mo., bank protection	23,844.18	7,283.92	31,128.10
Liberty Island, dam	5,053.91		5,053.91
Liberty Island, bank protection	151,245.41	10,185.69	161,431.10
Liberty Island, hurdles	182,364.88		182,364.88
Hamburg, hurdles		67,493.29	67,493.29
Devils Island, dike No. 1	65,871.17		65,871.17
Devils Island, dams 1 and 2	66,526.88		66,526.88
Devils Island, bank protection		46,994.19	46,994.19
Devils Island, hurdles		10,425.88	10,425.88
Minton Point, hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdles	31,930.18		31,930.18
Cape Girardeau, hurdles		43,515.46	43,515.46

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Total cost of works to June 30, 1898—Continued.

Name of work.	Expended—		Total.
	Prior to July 1, 1897.	During year 1897–98.	
Commerce Island, Mo., hurdles	.....	$45,932.67	$45,932.67
Power Island, Mo., hurdles	$95,633.12	7,505.26	103,138.38
Buffalo Island, Ill., hurdles	.....	98,023.22	98,023.22
Beach Ridge, Ill., bank protection	.....	50,961.09	50,961.09
Cairo, bank protection	160,439.82	.....	160,439.82
Portable jetties, operating	44,202.69	31,138.41	75,341.10
Dredging	24,553.02	34,332.30	58,885.32
Total	6,294,142.31	696,950.78	6,991,093.09

PROPERTY ACCOUNT.

Class of property.	Value July 1, 1897.	Debits.	Credits.	Value June 30, 1898.
Steamer Gen. Gillmore	$17,296.83	$14,232.66	$29,529.49	$2,000.00
Steamer Gen. T. L. Casey	22,754.31	18,513.11	20,513.11	20,754.31
Steamer Gen. H. L. Abbot	38,678.81	30,025.08	33,625.08	35,078.81
Dredge No. 1	20,856.72	9,219.88	11,219.88	18,856.72
Dredge No. 2	25,966.19	13,295.84	15,295.84	23,966.19
Dredge No. 3	601.49	114,966.96	.....	115,568.45
Dredge No. 4	601.49	106,944.82	.....	107,546.31
Steam tenders	25,724.83	8,551.82	6,615.31	27,661.34
Barges, model	152,895.16	77,843.91	29,000.73	201,738.34
Barges, quarter	10,866.55	955.73	4,555.73	7,266.55
Quarter boats	50,856.11	8,088.64	12,088.64	46,856.11
Office and survey boats	13,929.28	258.90	1,833.90	12,354.28
Pile drivers	123,146.73	6,683.19	18,933.19	110,896.73
Derrick boats	3,921.57	1,867.28	1,400.46	4,388.39
Derricks	1,560.96	2,003.21	240.98	3,323.19
Machine shop	1,979.43	3,116.67	2,478.73	2,617.37
Small boats	32,405.97	13,290.84	21,794.92	23,901.39
Portable quarters	3,969.31	1,213.74	1,356.53	3,826.52
Jetty gates	26,361.46	2,919.31	7,927.99	21,352.78
Ways (supply depot)	2,514.41	792.14	1,269.88	2,036.67
Supply depot	8,429.07	3,375.80	3,766.56	8,038.31
Tools and appliances	21,223.87	10,856.08	14,175.09	17,904.86
Boarding outfit	26,249.23	8,320.38	8,233.37	26,336.24
Office furniture	476.20	.....	.....	476.20
Survey instruments	1,844.35	.....	184.43	1,659.92
Photographic apparatus	257.14	.....	.....	257.14
Total	635,367.47	457,335.49	246,039.84	846,663.12

MATERIAL ACCOUNT.

Class of material.	Value July 1, 1897.	Debits.	Credits.	Value June 30, 1898.
Subsistence	$3,109.67	$63,261.50	$63,803.88	$2,567.29
Brush	1,973.18	51,439.74	53,414.92	.....
Piles	7,613.83	84,476.27	90,805.23	1,284.87
Stone	1,193.99	111,917.38	110,267.40	2,842.97
Rope	28,242.70	6,682.89	15,950.08	19,075.51
Wire	1,705.54	4,583.86	5,531.68	757.72
Iron	2,575.10	5,946.82	3,295.34	5,226.58
Nails	1,295.84	589.55	1,214.63	670.76
Spikes	1,836.03	1,022.50	1,854.80	1,003.73
Bolts, screw	741.83	.....	116.67	625.16
Bolts, assorted	29.69	.....	11.79	17.90
Clevises	196.02	164.89	147.00	213.91
Lumber	7,728.42	25,022.46	25,649.98	7,100.90
Lumber (linear feet)	1.74	.....	.....	1.74
Oakum	144.98	1,133.00	800.73	477.25
Coal	1,081.42	84,002.53	82,600.70	2,483.25
Coal, blacksmiths'	3.35	159.76	143.40	19.71
Ice	.....	5,838.22	5,838.22	.....
Material, miscellaneous	6,586.56	25,373.04	23,196.92	8,762.68
Total	66,158.89	421,616.41	434,643.37	53,131.98

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REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1898.*

MAJOR: I have the honor, respectfully, to submit the following report upon the improvement of the Mississippi River between the Ohio and Missouri rivers for the fiscal year ending June 30, 1898.

The year's operations comprise the construction, extension, and repair of works for the improvement of the reach, and temporary expedients for the relief of its navigation at the following localities: Arsenal Island, Twin Hollows, Chesley Island, Riverside, Harrisonville, Platin Rock, Michaels Landing, Osborne Field to Durfees Landing, Danbys Landing, Sycamore Landing, Turkey Island, Ste. Genevieve (Ill.) to Moro Island, Ste. Genevieve (Mo.), Chester, Anchor Landing, Liberty, Seventy-six Landing, foot of Grand Tower Bend, Hamburg, head of Devils Island, foot of Devils Island and Mintons Point to Cape Girardeau, Juden Creek, Commerce, Doolans Slough, Goose Island, and Buffalo Island.

ARSENAL ISLAND.

At Arsenal Island four hurdles were built. In length they aggregated 4,400 feet, distributed as follows: No. 1, 1,000 feet; Nos. 2 and 3, each, 1,400 feet; and No. 4, 600 feet. They were of the ordinary type, spaced about 1,700 feet apart, with buttresses at their river ends, substantial protection at their shore ends, and with cribbed drift mattress placed above the piling in parts having excessive depths of water. In location three are above the head of the island, and one crosses the cut from the new bank to the old revetment.

The quantities of work are: Piles driven, 4,532; stringers placed, 239; foundation mattress fabricated and sunk, 5,977 linear or 616,532 square feet; of drift mattress, 1,250 linear or 32,049 square feet fabricated and sunk; of revetment placed, 1,160 linear or 67,660 square feet; 770 linear or 7,460 square feet of curtains fabricated and placed, and three buttresses built.

As an immediate effect, there was an increase in the depth of the channel across the bar in that vicinity.

TWIN HOLLOWS—EAST SIDE.

At Twin Hollows, east side, the revetment placed there in 1882 and following years was repaired to the contour of 16 feet above standard low water, or to the top of the old work whenever it was at or below that plane. There was no extension of the revetment to higher planes, and most of the new work extended no higher than 12 feet above standard low water. The quantity of work was 4,077 linear or 150,194 square feet of revetment placed.

CHESLEY ISLAND.

The revetment at the head of Chesley Island had been damaged by a surface cut in oval shape about 150 feet by 50 feet, leaving the old protection mattress undisturbed on its river side, but with 18 feet depth below standard low water on its bank side. The revetment was thoroughly repaired with stone and spalls to the stage of 16 feet above standard low water, in which the work was 200 linear or 23,000 square feet of revetment placed.

MICHAELS LANDING.

The work of constructing Hurdle No. 2 at Michaels Landing, which was in progress at the beginning of the fiscal year, was prosecuted to completion, including a stone dike connection with the Missouri shore, the revetment of Osborne Towhead, and the reinforcement of the piling by sinking a large body of drift above it. In sinking the drift, the mattress used was made of common cull lumber 1 inch thick by 4 to 6 inches wide and in lengths not less than 12 feet, on account of the small available supply of brush. The lumber served the purpose well, and its use was economical and advantageous to the Government.

In Hurdle No. 1 a few piles were driven and bolts were tightened as required, but on account of excessive depths of water—which ranged from 35 to 45 feet—no attempt was made to close the gap in Hurdle No. 1 referred to in the report for 1897.

OSBORNE FIELD—DURFEES LANDING.

The revetment from Osborne Field to Durfees Landing was repaired in part only for the purpose of placing it in condition to pass through another season's high stages without injury, which necessitated repairs distributed upon a distance of 7,000 feet from the lower end of the work at Durfees Landing, in which the quantity of work done was 4,735 linear or 102,540 square feet of revetment placed.

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DANBYS LANDING.

The revetment at Danbys Landing was repaired and placed in condition to safely pass through another high stage of the river. The larger portion of the work done was from the lower end to a distance about halfway up the revetment, where the river had begun cutting behind the stonework which had not been carried above the contour of 16 feet above standard low water. The quantity of work done was 1,775 linear or 46,500 square feet of revetment placed.

SYCAMORE LANDING.

The work at Sycamore Landing was the repair and extension toward completion of the revetment placed during 1892 and following years.

Upon part of this protection the subaqueous mattress only had been placed. By this year's work the revetment was extended to the 10-foot contour and remainder of the revetment was repaired, in which 1,500 linear or 70,475 square feet of revetment was placed.

TURKEY ISLAND.

At Turkey Island the work was in extension and repair of the protection placed during 1895 and 1896. The revetment upon about one-third of its length from its lower end was extended up the bank to the 10-foot contour and the remainder was repaired, in which 75,700 square feet of revetment was placed upon a length of 2,200 feet.

STE. GENEVIEVE, ILL.

At Ste. Genevieve, Ill., the work comprised the repair of Hurdles Nos. 12 and 15 and restoring the bank of Moro Island, which had been cut away by the spring freshets. Hurdle No. 12 had suffered no damage except that its river end had been worn off or broken down to a distance of about 200 feet. This could not be restored because of the depth of water due to the pour around the end of the hurdle, but the end was strengthened to prevent extension of the damage.

A large mass of drift had collected above the hurdle along its entire length and in order to strengthen the hurdle to sustain the pressure from the mass of drift about 400 piles were driven in clumps of three behind the hurdle and as close to it as possible, and all loose bolts and cables were tightened or replaced by others. In Hurdle No. 15 two gaps had been made by the ice and high water of the past winter and spring. The larger gap was 200 feet wide, with depths ranging from 25 to 30 feet at a 15-foot stage of river. The smaller gap was only 60 feet wide with 20 feet maximum depth. The hurdle was restored across both gaps with foundation mattress and a triple row of piling in clumps, and above the larger gap was extended in a V shape, forming a double hurdle. The old piling was strengthened with a row of clumps. All cables were tightened and shore-end revetments were repaired and extended.

At Moro Island the bank had been cut away behind the protection placed in 1895 and 1896 upon a length of 3,000 feet and to a maximum width of 400 feet. To prevent further erosion and to restore the bank to its original position five hurdles were built across the cut from the new bank to the old revetment which still remained in place as an obstruction to navigation at low and medium stages of water. These hurdles were spaced about 650 feet apart, and in their length sloped from the stage of 25 feet to that of 15 feet above low water. Their lengths ranged from 50 feet to 390 feet and aggregated 1,150 feet. The shore-end revetments were carried up to the 20-foot contour above and the 15-foot contour below these hurdles, and were built heavier and longer than usual, to protect the soft bank.

STE. GENEVIEVE, MO.

The work at Ste. Genevieve, Mo., was the construction of Hurdle No. 18 and the protection of the bank to a distance of 5,600 feet below it, to the dry sand bar at the foot of Fairy Island. The subaqueous zone was protected by a mattress about 125 feet wide and by a stone revetment above, about to the 10-foot contour. The mattress to a distance of about 1,600 feet from its lower end was built of 1-inch cull lumber 4 inches to 6 inches wide, and in length not less than 12 feet. On account of the scarcity of suitable brush, this material was used at several localities as a substitute for it, and is well adapted for the purpose, easy to handle, and makes a strong, flexible mattress. The remainder of the mattress was of brush woven on poles in the usual way, but was strengthened by extra cables, wiring, and a top grillage of heavy poles to withstand the swift current along the bank and the waves from passing steamers. Notwithstanding the precautions taken, the mattress was broken several times before partial relief was obtained by dredging across the point of the upper bar, thereby securing a channel for passing steamers farther from the bank.

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Hurdle No. 18 was built just above the head of the mattress, for purposes of both contraction and protection. Its projected length is 1,300 feet, but on account of the proximity of the navigable channel to the bank during the season only 460 feet were built.

The quantities of work are: In Hurdle No. 18, piles driven, 396; stringers placed, 4; foundation mattress fabricated and sunk, 1,020 linear or 106,472 square feet; in the bank protection 57 piles were driven, 6,310 linear or 799,915 square feet of mattress fabricated and sunk, 2,700 cubic yards of earth removed in grading, and 5,585 linear or 150,795 square feet of revetment placed.

CHESTER.

At this locality the work was the repair and extension to higher planes of the bank protection opposite Chester, Ill. The revetment was repaired and extended up to the foot of the bluff bank about to the 20-foot contour throughout its entire length of 3,310 feet, in which 147,837 square feet of revetment was placed.

LIBERTY.

The work at Liberty comprised the repair and extension to higher planes of the bank protection in the vicinity of Anchor Landing, Missouri, and Wagners Landing, Ill. At Anchor Landing the revetment was repaired, in which 3,912 linear or 57,692 square feet of revetment was placed; at Wagners Landing the revetment was both repaired and extended to the 10-foot contour as required to make that its minimum height, in which 3,915 linear or 115,280 square feet of revetment was placed.

HAMBURG CHUTE.

In closing Hamburg Chute Hurdles Nos. 5 and 6, in aggregate length 4,085 feet, were built. No. 5 was located near the head of Hamburg Island and No. 6 about 6,600 feet farther downstream.

At the low stage prevailing when the construction of No. 5 was begun a shoal existed near its east end and a bar near its middle. In order to pass over the shoal water the piles were driven in advance of the placing of the foundation mattress as was done in older forms of construction. The piles were driven in three rows 18 feet apart, with spaces between piles 6 feet in middle and 12 feet in the other rows. The hurdle was strengthened by braces, longitudinal and cross stringers, upon the distance 575 feet from the Illinois shore, built in this form, thence to the bar line of Hamburg Island was built in the usual form of three-pile clumps staggered in two rows and thence a single row of three-pile clumps to the high ground on the island. The piles in the last-named section were driven by jets of water furnished by pile drivers through long lines of pipe and hose. The ends of the hurdle were well protected by subaqueous mattress of usual type and revetment above to the top of the bank. Curtains were placed on the upper side of the hurdle below the plane 8 feet above standard low water.

Hurdle No. 6 was located below a caving bend in the east bank, about 6,600 feet below No. 5, on account of the favorable section there for hurdle construction.

The foundation mattress was made 112 feet wide throughout the entire length of the hurdle, and for the protection of the shore 300 feet at each end; a double row of staggered-pile clumps was driven as the general form, which was reinforced in the deep water near the island end of the hurdle. Stringers were placed between the clumps of consecutive rows. The island end was revetted to the top of the bank upon the full length, 300 feet, of the protection and the other end to a distance of 220 feet from the head of the protection. Curtains were placed to the plane of 8 feet above standard low water upon the entire length of hurdle. The quantities of work are: Piles driven, 3,294; braces placed, 206; stringers placed, 58; foundation mattress fabricated and sunk, 622,055 square feet; curtains fabricated and placed, 36,430 square feet; revetment placed, 43,184 square feet; earth removed in grading, 1,530 cubic yards. Hurdles Nos. 5 and 6 were broken, as shown in Plate III, and have not been repaired.

DEVILS ISLAND.

The work at Devils Island comprised the construction of Hurdle No. 1, 1,200 feet long, the protection of the bank at Swift Sure, the head and west face of Devils Island.

Hurdle No. 1 was built across the head of the chute passing east of Devils Island. It closes the chute and connects the bank protection at Swift Sure with that of Devils Island. The foundation mattress was built 200 feet in width, of which 120 feet was above the center line of the hurdle for the protection against scour by the current parallel to the hurdle. In other respects the hurdle was built in the usual form, by a double row of pile clumps across the chute, connected with the bank pro-

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tection above and below, at the stage of 8 feet above standard low water, by a single row of clumps.

The mattress for the protection of the bank was of the standard type, 120 feet wide and 7,070 feet long, as follows: 1,650 feet on Swift Sure above Hurdle No. 1, 1,100 feet along the front of the hurdle, and 4,320 feet on the head and west face of Devils Island. The revetment extended to the foot of the bluff bank from the head of the protection to a distance of 4,970 feet, ranging between 8 feet and 14 feet above standard low water, and thence to the lower end of the mattress to about the lower of these planes.

The quantities of work are: In Hurdle No. 1, piles driven, 911; stringers placed, 71; foundation mattress fabricated and sunk, 129,925 square feet; in bank protection, 7,070 linear or 865,100 square feet of mattress fabricated and sunk; 6,645 linear or 279,393 square feet of revetment placed, and 500 cubic yards of earth removed in grading.

MINTON POINT TO CAPE GIRARDEAU.

The work at this locality was the construction of Hurdles Nos. 9 and 11 near the foot of Devils Island.

Hurdle No. 9 was located about 1,000 feet above and No. 11 about the same distance below old Dike No. 1. No. 9 was built in usual form with piling in three rows of clumps and with stringers placed between alternate rows. Its shore end was protected to the top of the bank and its river end by clumps of piling above the hurdle driven through the shore end of the tee-head mattress. The hurdle was not curtained as the driftwood collected above it checked the current sufficiently. A drift mattress 300 feet long and 40 feet wide was fabricated and sunk at the shore end of the hurdle.

In Hurdle No. 11 the piling was driven in clumps in two rows, with an additional row near its river end. Its connection with the high bank was made by a single row of clumps across the shore bar. Its river and shore ends were protected similarly to those in No. 9. Curtains were placed to the stage of 4 feet above standard low water.

The quantities of work are: Piles driven, 2,544; stringers placed, 101; foundation mattress fabricated and sunk, 333,280 square feet; drift mattress fabricated and sunk, 12,000 square feet; curtains fabricated and placed, 15,020 square feet; revetment placed, 16,089 square feet; earth removed in grading, 2,950 cubic yards.

COMMERCE ISLAND.

The work at Commerce Island was in construction of Hurdle No. 5 of the series projected for that locality. Work was in progress at the close of the year. The length of the hurdle as projected is 2,850 feet, extending from Commerce Island to Allens Towhead and passing tangent to the smaller towhead which lies between. The foundation mattress, 120 feet wide, was built in one continuous section connecting with shore protections 350 feet long on the island and 550 feet on the head of Allens Towhead. Of the total mattress built, 1,550 linear feet between the island and the middle towhead was of brush and the remainder of lumber. The revetment of the head of Allens Towhead was completed to the top of the bank, but that of Commerce Island was incomplete at the close of the year.

The piling was driven in three rows of three-pile staggered clumps, with longitudinal stringers between consecutive rows to secure to the upper row contact with and support of those below it. Equivalent length of hurdle constructed was 2,650 feet, in which the quantities of work are: Piles driven, 3,020; stringers placed, 136; mattress fabricated and sunk, 451,660 square feet, and revetment placed, 18,670 square feet.

DOOLANS SLOUGH.

At Doolans Slough the work comprised repair and strengthening of the hurdle dam built there during the preceding year. The shore revetment and stone dikes connecting the dam with shores were repaired and the drift collected above the dam was distributed along its entire length and sunk, and cables were tightened and replaced as required. The mattress used in sinking drift was of the cull-lumber type, as at Michaels Landing, hereinbefore described.

The following are the quantities of work: Drift mattress fabricated and sunk, 1,265 linear or 41,120 square feet, and 15,210 square feet of revetment placed.

BUFFALO ISLAND.

At Buffalo Island the work was in the construction of Hurdle No. 8 of the series projected for the improvement of that locality. The work was begun March 23, 1898, and was in progress at the close of the fiscal year. The hurdle closes the waterway east of Blackbird Island, which has frequently contained the low-water channel.

The stages of river during April while the foundation mattress was under process

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of construction were unfavorable from back water from the Ohio River, which was then in flood, showing from 30 to 50 feet above low water on the Cairo gauge, which gave excessive depths, especially in the deep water near shore. The mattress was built and placed in three sections, to facilitate the progress of pile driving during the higher stages of water, with the material on hand, and to insure the completion of the hurdle over the middle bar which would become dry at low stages. The shore at the Illinois end of the hurdle was protected upon a distance of 230 feet and at the island end a total distance of 900 feet, of which 350 feet was on the channel side of the island and in extension of the hurdle.

Lumber was first used here in the construction of foundation mattress and with satisfactory results. The rate of construction is greater with same force, but it may require more ballasting within the limits covered by piling than a brush mattress would, but on the whole lumber makes a good substitute for brush.

The piling was driven in three rows of staggered clumps, the lower rows supporting the upper by contact with longitudinal stringers placed between consecutive rows.

When the piling was nearly completed a sudden rise in the Mississippi River of 6 feet, followed a few days later by another of 6 feet, or a total of 12 feet rise to the stage of 27 feet, greatly increased the current across the hurdle and caused scour to depths ranging between 8 and 16 feet. This was checked by the liberal use of stone in reballasting the mattress and the damage was repaired by driving additional piles to strengthen the hurdle where weakened by scour. Drift collected above the hurdle was in process of being sunk at the close of the year.

The equivalent length of hurdle constructed was 3,050 feet in which the quantities of work are: Piles driven, 4,814; stringers placed, 345; foundation mattress fabricated and sunk, 437,425 square feet; drift mattress fabricated and sunk, 130,200 square feet, and revetment placed, 8,785 square feet.

TEMPORARY EXPEDIENTS.

Upon the approach of low water portable jetties were placed and dredging was done at several localities to improve navigation temporarily. Portable jetties were placed and dredging done at Riverside, Upper Harrisonville, Platin Rock, Seventy-six Landing, Juden Creek, and Buffalo Island, and dredging alone was done at foot of Grand Tower Bend, Minton Point, and Goose Island.

At Riverside dredge No. 2 began work August 21 for the purpose of keeping a channel open by the railway incline at the terminus of the Mississippi River and Bonne Terre Railway. The dredge worked at this locality until October 12 and was assisted occasionally by the *Abbot*, and a jetty 1,100 feet long placed about September 1. A depth of about 4 feet was maintained. The channel was not used in the general navigation of the river, but the current flowing through it kept the landing at the railway incline open, which otherwise would have been closed during the greater part of the season.

At Upper Harrisonville the crossing was improved by cutting a channel through the bar by dredge No. 2, which partly filled and was reopened by the *Abbot* and was kept open to the close of the season by a portable jetty 1,000 feet long. At Harrisonville a jetty 840 feet long was placed, and the *Abbot* dredged a channel through the bar. At Platin Rock a jetty 2,230 feet long was placed, and the steamers *Casey* and *Abbot* were used in passing to assist in opening a channel through the bar. In Old River, near Chester, dredge No. 2 opened a channel through the bar which obstructed the entrance to the harbor which had been used several years to protect floating plant during the winter.

At Seventy-six Landing a jetty 1,700 feet long was placed which, with the assistance of the *Abbot* in opening the channel, maintained it throughout the season.

At the foot of Grand Tower Bend dredge No. 1, in conjunction with the *Casey*, opened a channel through the bar which, on account of the small velocity of flow, was maintained with considerable difficulty by dredging several times by No. 1 and the *Casey*, and by both steamers *Casey* and *Abbot* separately.

At Juden Creek a jetty 650 feet long was placed and the steamers *Abbot* and *Casey* worked as required to keep the crossing open.

The crossing from Minton Point to Cape Girardeau was opened by the steamers *Casey* and *Abbot*.

The Goose Island crossing was dredged by the *Abbot* several times during the season.

At Buffalo Island 1,825 feet of jetties were placed in three nearly parallel lines, and dredge No. 1, steamer *Abbot*, and steamer *Casey* worked there to open and maintain a navigable channel.

In the aggregate, 9,345 feet of jetties were placed. Dredges Nos. 1 and 2 worked as required, and steamers *Abbot* and *Casey* as required, and whenever their services were not more urgently needed in towing and other work connected with the improvement.

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PROCURING MATERIAL.

The brush used, 30,522.3 cords, was procured by hired labor, but on account of the scarcity of suitable brush, lumber was substituted for it in part, and the quantity required was procured by purchase, after canvassing market, under sealed proposals. The piling required was procured by contract.

Of the stone required, 32,981.6 cubic yards were procured by contract and 10,571.1 cubic yards by purchase in open market, and the remainder by hired labor, 91,931.8 cubic yards.

PLANT.

The plant was constructed, repaired, and outfitted as required. The construction comprised 18 model barges, and dredges Nos. 3 and 4 with their outfits complete. Minor construction, and such repairs as pertain to construction account, comprised barges, quarters, and tools and appliances. Minor repairs were made as required, and comprised the towboats *Abbot*, *Casey*, and *Gillmore*, dredges Nos. 1 and 2, tenders, barges, quarter barges, quarter boats, boarding outfit, derrick boats, pile drivers, small boats, tools and appliances, and engineer depot.

RESULTS.

The year's work contributed largely to the elimination of the crossings at Arsenal Island, foot of Ste. Genevieve Bend, in the reach from Moccasin Springs to Cape Girardeau, and although sufficient time has not elapsed for full development of results of works at Commerce and Buffalo islands, the reach between these points will probably be greatly improved as a result of this year's works. The temporary expedients contributed largely to the alleviation of navigation interests.

SURVEYS, GAUGES, AND STAGES OF RIVER.

Only the local surveys required in connection with the works were made, but in doing this connection was made with the Mississippi River Commission secondary triangulation points, "Bluff Lake" and "Rich," and within the reach from Moccasin Springs to Cape Girardeau fourteen permanent triangulation points were established, besides connecting with seven Mississippi River Commission points and two points established by this office in 1874.

Test borings were made in the chute on the Missouri side of Grand Tower Island to determine the practicability of improving the chute for the navigable channel.

A survey was also made from the works at Beech Ridge to the mouth of Cache River in connection with the bank protection at that locality. The gauges established along the reach were read daily and were repaired as required. That at St. Louis ranged between 23.2 and —4.4 feet above standard low water.

Six discharge observations were made during the low-water season, of which three were at St. Louis and three in Kaskaskia Chute.

REPORTS OF ASSISTANTS IN LOCAL CHARGE.

Much of the information contained in this report was obtained from the reports of assistants in local charge. This is especially the case with tables and statements of work done as well as other details, as follows: Upon works at Arsenal Island, Twin Hollows, Chesley Island, Michaels Landing, Osborne Field to Durfees Landing, Danbys Landing, Sycamore Landing, Turkey Island, Ste. Genevieve, Illinois and Missouri, Chester, Liberty, Doolans Slough, together with all portable jetties, to the report of Mr. W. S. Mitchell, assistant engineer; upon works at Hamburg Island, Devils Island, Minton Point to Cape Girardeau, Commerce Island, and Buffalo Island, to the report of Mr. John O. Holman, assistant engineer; upon procuring brush and stone by hired labor, to the report of Mr. E. D. Libby, assistant engineer; for construction, repairs, and outfitting plant at engineer depot, to the report of Mr. C. D. Lamb, superintendent; to operations of dredges Nos. 1 and 2, each to the reports of their respective masters, C. B. White and E. C. Wiley.

PLATES.

For further information reference is made to the accompanying tables, Nos. I, II, III, IV, and V, showing location and extent of works.

TABLES.

Quantities of work done are shown in detail in the appended tables.

Very respectfully, your obedient servant,

D. M. CURRIE, *Assistant Engineer.*

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

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PLATE I.

MISSISSIPPI RIVER

MAP SHOWING CONDITION OF WORKS OF IMPROVEMENT IN VICINITY OF

ARSENAL ISLAND

June 30, 1898.

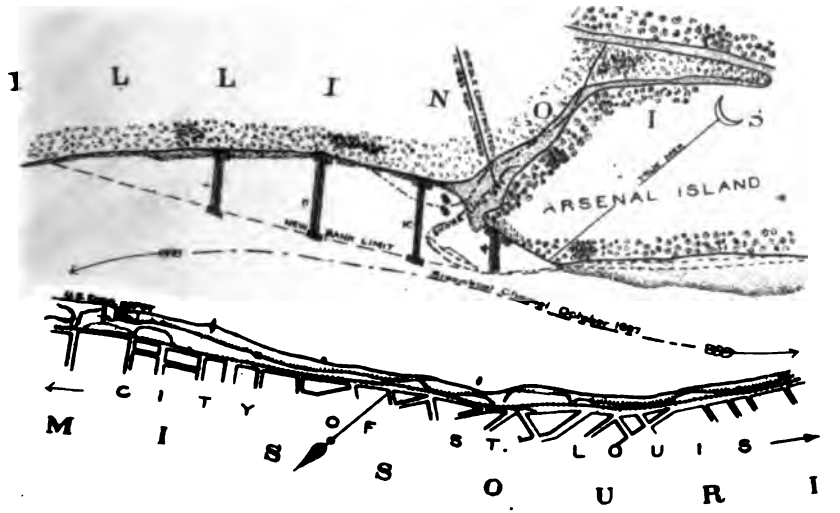
SCALE

1000 500 0 1 2 3 4 5 6 7 8000

Bars are shown as they appeared Oct. 27, 1897 at approximate standard low water stage.

Hurdles etc. built during this fiscal year shown thus [illegible]

" " " prior to " " " " " " —— ⊏⊏⊏⊐



U.S. Engineer Office, Custom House, St Louis, Mo.

Sent to Chief of Engineers U.S.A. with Annual Report for fiscal year ending June 30, 1898.

Major Corps of Engineers, U.S.A.

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PLATE III.

Ree, Custom House, St. Louis, Mo.
s U.S.A. with Annual Report for
, 1898.

Major Corps of Engineers, U.S.A.

KINNEY

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ER.

IMPROVEMENT

nd CAPE GIRA

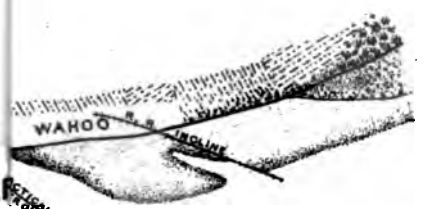

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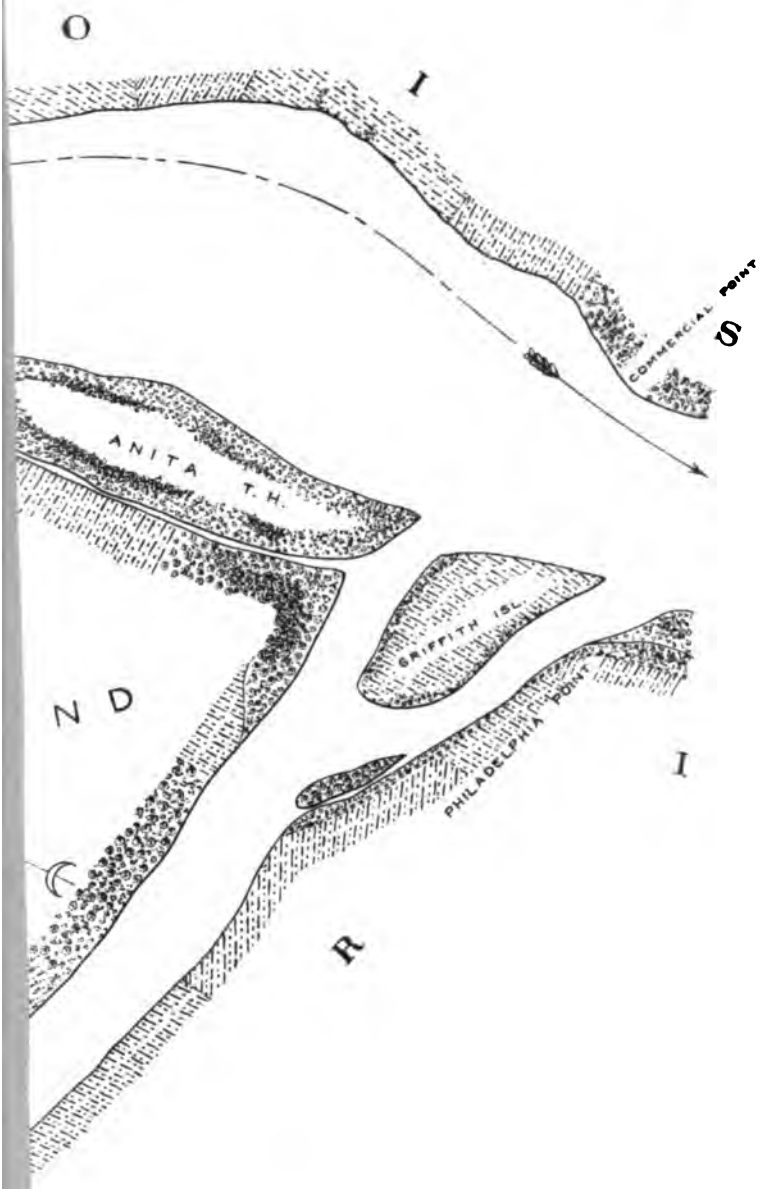
PLATE IV.



U.S. Engineer Office, Custom House, St. Louis, Mo.
nt to Chief of Engineers, U.S.A., with Annual Report for
year ending June 30, 1898.

Thos. H. Handbury
Major Corps of Engineers, U.S.A.

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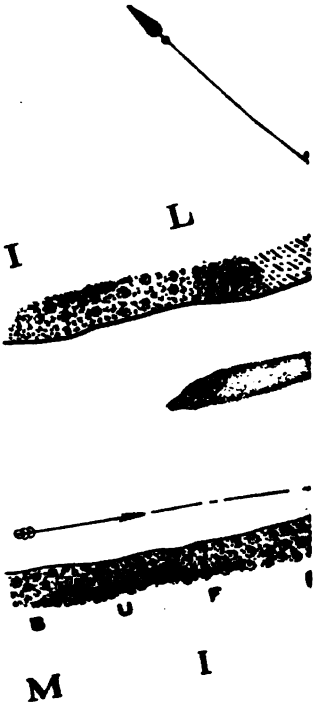

MAP

Bars are shown
low water
Hurdles etc.

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Table of work done during the fiscal year ending June 30, 1893.

	Arsenal Island, Ill.					Twin Hollows, Ill.	Chesley Island, Mo.
	Hurdle No. 1.	Hurdle No. 2.	Hurdle No. 3.	Hurdle No. 4.	Total.	Bank protection.	Bank protection.
Lengths of work projected, feet	1,000	1,400	1,400	600	4,400	.....	.....
Equivalent lengths built, feet	1,000	1,400	1,400	600	4,400	.....	.....
Piles driven.....number..	1,039	1,375	1,414	704	4,532	.....	.....
Piles driven, penetration, feet	19,827	25,730	26,124	13,119	84,800	.....	.....
Braces placed .....number..	.....	.....	.....	.....	.....	.....	.....
Stringers placed .....do....	50	67	75	45	237	.....	.....
Foundation mattress fabricated and sunk, linear feet..	1,370	1,735	1,955	917	5,977	.....	.....
Do .....square feet..	137,000	182,950	192,912	103,670	616,532	.....	.....
Drift mattress fabricated and sunk. .....linear feet..	420	630	200	.....	1,250	.....	.....
Do .....square feet..	8,400	17,640	6,000	.....	32,040	.....	.....
Bank protection mattress fabricated and sunk, linear feet	.....	.....	.....	.....	.....	.....	.....
Bank-protection mattress fabricated and sunk, square feet	.....	.....	.....	.....	.....	.....	.....
Curtains placed..linear feet..	180	350	120	120	770	.....	.....
Do .....square feet..	1,800	3,500	960	1,200	7,460	.....	.....
Stone revetment placed, linear feet.....	125	300	300	435	1,160	4,077	200
Stone revetment placed, square feet.....	17,355	15,650	15,080	19,575	67,660	150,194	23,000
Grading.....linear feet..	.....	.....	.....	.....	.....	.....	.....
Do.....cubic yards..	.....	.....	.....	.....	.....	.....	.....
Buttresses built....number..	1	1	1	.....	3	.....	.....

	Michaels Landing, Mo.			Osborne Field, Ill.	Danby Landing, Mo.	Sycamore Landing, Ill.	Turkish Island, Ill.
	Hurdle No. 1.	Hurdle No. 2.	Total.	Bank protection.	Bank protection.	Bank protection.	Bank protection.
Lengths of work projected, feet	2,900	2,800	5,700	.....	.....	.....	.....
Equivalent lengths built, feet	.....	800	800	.....	.....	.....	.....
Piles driven.....number..	9	1,526	1,535	.....	.....	.....	.....
Piles driven, penetration, feet	134	29,429	29,563	.....	.....	.....	.....
Braces placed .....number..	.....	.....	.....	.....	.....	.....	.....
Stringers placed .....do....	.....	.....	.....	.....	.....	.....	.....
Foundation mattress fabricated and sunk, linear feet..	.....	1,275	1,275	.....	.....	.....	.....
Foundation mattress fabricated and sunk, square feet	.....	159,375	159,375	.....	.....	.....	.....
Drift mattress fabricated and sunk .....linear feet..	.....	1,350	1,350	.....	.....	.....	.....
Do .....square feet..	.....	31,600	31,600	.....	.....	.....	.....
Bank-protection mattress fabricated and sunk, linear feet	.....	.....	.....	.....	.....	.....	.....
Bank-protection mattress fabricated and sunk, square feet	.....	.....	.....	.....	.....	.....	.....
Curtains placed..linear feet..	.....	.....	.....	.....	.....	.....	.....
Do.....square feet..	.....	.....	.....	.....	.....	.....	.....
Stone revetment placed, linear feet.....	.....	780	780	4,735	1,775	1,500	2,200
Stone revetment placed, square feet.....	.....	23,700	23,700	102,540	46,500	70,475	75,700
Grading .....linear feet..	.....	.....	.....	.....	.....	.....	.....
Do .....cubic yards..	.....	.....	.....	.....	.....	.....	.....
Buttresses built....number..	.....	.....	.....	.....	.....	.....	.....

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Table of work done during the fiscal year ending June 30, 1898—Continued.

	Ste. Genevieve, Ill. (Moro Island).							
	Hurdle No. 12.	Hurdle No. 15.	Hurdle No. 0.	Hurdle No. 1.	Hurdle No. 2.	Hurdle No. 3.	Hurdle No. 4.	Total.
Lengths of work projected...feet..	1,550	1,300	110	270	390	330	50	4,000
Equivalent lengths built.....do...	.....	.....	110	270	390	330	50	1,150
Piles driven .....number..	415	1,241	116	293	452	371	40	2,928
Piles driven, penetration.....feet..	8,781	23,942	2,039	5,805	8,792	7,184	786	56,329
Braces placed .....number..	.....	.....	.....	.....	.....	.....	.....	.....
Stringers placed.....do...	.....	25	4	.....	.....	12	.....	41
Foundation mattress fabricated and sunk.....linear feet..	.....	1,128	.....	.....	.....	.....	.....	1,128
Do .....square feet..	.....	144,088	.....	.....	.....	.....	.....	144,088
Drift mattress fabricated and sunk .....linear feet..	.....	.....	.....	.....	.....	.....	.....	.....
Do .....square feet..	.....	.....	.....	.....	.....	.....	.....	.....
Bank protection mattress fabricated and sunk.....linear feet..	.....	.....	267	591	725	625	240	2,448
Do .....square feet..	.....	.....	32,216	80,376	98,600	85,000	25,200	321,392
Curtains placed .....linear feet..	.....	417	.....	295	400	325	.....	1,437
Do .....square feet..	.....	10,153	.....	4,365	5,000	4,200	.....	23,718
Stone revetment .....linear feet..	.....	445	654	400	443	540	350	2,832
Do .....square feet..	.....	27,450	24,008	9,730	13,708	15,459	17,700	107,055
Grading.....linear feet..	.....	145	.....	405	400	390	.....	1,340
Do .....cubic yards..	.....	300	.....	1,876	1,660	2,022	.....	5,858
Buttresses built .....number..	.....	.....	.....	.....	.....	.....	.....	.....

	Ste. Genevieve, Mo.		Chester, Mo.	Anchor Landing, Mo.	Wagners Landing, Ill.
	Hurdle No. 18.	Bank protection.	Bank protection.	Bank protection.	Bank protection.
Lengths of work projected.....feet..	1,300	5,600	3,300	3,912	3,915
Equivalent lengths built .....do...	460	5,585	3,300	3,912	3,915
Piles driven.....number..	396	57	.....	.....	.....
Piles driven, penetration .....feet..	7,573	1,288	.....	.....	.....
Braces placed .....number..	.....	.....	.....	.....	.....
Stringers placed.....do...	4	.....	.....	.....	.....
Foundation mattress fabricated and sunk.....linear feet..	1,020	.....	.....	.....	.....
Do .....square feet..	106,472	.....	.....	.....	.....
Drift mattress fabricated and sunk, linear feet.....	.....	.....	.....	.....	.....
Drift mattress fabricated and sunk, square feet.....	.....	.....	.....	.....	.....
Bank-protection mattress fabricated and sunk .....linear feet..	.....	6,310	.....	.....	.....
Do .....square feet..	.....	799,915	.....	.....	.....
Curtains placed.....linear feet..	.....	.....	.....	.....	.....
Do .....square feet..	.....	.....	.....	.....	.....
Stone revetment .....linear feet..	.....	5,585	3,300	3,912	3,915
Do .....square feet..	.....	150,795	147,837	57,692	115,280
Grading .....linear feet..	.....	1,005	.....	.....	.....
Do .....cubic yards..	.....	2,700	.....	.....	.....
Buttresses built.....number..	.....	.....	.....	.....	.....

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Table of work done during the fiscal year ending June 30, 1898—Continued.

	Hamburg, Ill.			Devils Island (head).	
	Hurdle No. 5.	Hurdle No. 6.	Total.	Hurdle No. 1.	Bank protection.
Lengths of work projected ..... feet..	2,860	1,225	4,085	1,200	.....
Equivalent lengths built ..... do...	2,860	1,225	4,085	1,200	.....
Piles driven ..... number..	2,138	1,156	3,294	911	.....
Piles driven, penetration ..... feet..	40,144	22,073	62,217	16,156	.....
Braces placed ..... number..	206	.....	206	.....	.....
Stringers placed ..... do...	44	14	58	.....	.....
Foundation mattress fabricated and sunk ..... linear feet..	3,820	1,650	5,470	1,450	.....
Do ..... square feet..	432,574	189,432	622,006	129,925	.....
Drift mattress fabricated and sunk, linear feet	.....	.....	.....	.....	.....
Drift mattress fabricated and sunk, square feet	.....	.....	.....	.....	.....
Bank protection mattress fabricated and sunk ..... linear feet..	.....	.....	.....	.....	7,070
Do ..... square feet..	.....	.....	.....	.....	865,100
Curtains placed ..... linear feet..	2,360	1,225	3,585	.....	.....
Do ..... square feet..	26,400	10,080	36,480	.....	.....
Stone revetment placed ..... linear feet..	320	520	840	.....	6,645
Do ..... square feet..	14,201	28,983	43,184	.....	279,393
Grading ..... linear feet..	320	520	840	.....	900
Do ..... cubic yards..	100	1,430	1,530	.....	500
Buttresses built ..... number..	.....	.....	.....	.....	.....

	Devils Island (foot).			Commerce, Mo.	Power Island.	Buffalo Island.
	Hurdle No. 9.	Hurdle No. 11.	Total.	Hurdle No. 5.	Dam.	Hurdle No. 8.
Lengths of work projected ..... feet..	900	1,200	2,100	2,850	.....	3,050
Equivalent lengths built ..... do...	900	1,200	2,100	2,650	.....	3,050
Piles driven ..... number..	1,240	1,304	2,544	.....	.....	4,814
Piles driven, penetration ..... feet..	22,074	22,479	44,553	.....	.....	89,906
Braces placed ..... number..	.....	.....	.....	.....	.....	.....
Stringers placed ..... do...	71	30	101	.....	.....	345
Foundation mattress fabricated and sunk ..... linear feet..	1,360	1,500	2,860	3,441	.....	4,183
Do ..... square feet..	158,320	176,960	335,280	451,660	.....	437,425
Drift mattress fabricated and sunk, linear feet	300	.....	300	.....	1,285	.....
Drift mattress fabricated and sunk, square feet	12,000	.....	12,000	.....	41,120	.....
Bank protection mattress fabricated and sunk ..... linear feet..	.....	.....	.....	.....	.....	.....
Do ..... square feet..	.....	.....	.....	.....	.....	.....
Curtains placed ..... linear feet..	.....	1,200	1,200	.....	.....	.....
Do ..... square feet..	.....	15,020	15,020	.....	.....	.....
Stone revetment placed ..... linear feet..	310	120	430	580	745	470
Do ..... square feet..	14,045	2,044	16,089	18,670	15,210	8,785
Grading ..... linear feet..	310	.....	310	.....	.....	.....
Do ..... cubic yards..	2,950	.....	2,950	.....	.....	.....
Buttresses built ..... number..	.....	.....	.....	.....	.....	.....

	Portable jetties.							
	Riverside.	Upper Harrisonville.	Lower Harrisonville.	Platin Rock.	Seventy-six Landing.	Juden Creek.	Buffalo Island.	Total.
Lengths of work projected .. feet..	1,100	1,000	840	2,230	1,700	650	1,825	9,345
Equivalent lengths built ... do...	1,100	1,000	840	2,230	1,700	650	1,825	9,345
Piles driven ..... number..	85	77	48	156	148	71	192	777
Piles driven, penetration ... feet..	1,834	1,522	1,036	3,099	2,809	1,328	3,677	15,305
Piles recovered ..... number..	88	96	62	192	182	80	219	920
Stringers placed ..... do...	35	31	21	59	55	19	52	272
Panels placed ..... do...	121	109	84	226	186	66	195	987
Panels recovered ..... do...	121	104	80	214	177	62	185	943

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Table of jetties for the fiscal year ending June 30, 1898.

Location.	Length.	Dates of—		Channel depth when—		Gain in channel depth.		
		Placing.	Removal.	Placed.	Removed.	Total during life of jetty.	Due to oscillation local gauge.	Gain in depth due to jetty.
	Feet.			*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Riverside	1,100	Aug. 30 Sept. 3	Oct. 29 Nov. 5	(a)	(a)	(a)	(a)	(a)
Upper Harrisonville Crossing	1,000	Nov. 5	Nov. 26	5.50	6.00	+0.50	+0.10	0.50
Lower Harrisonville Crossing	840	Nov. 9 Oct. 4	Nov. 29 Oct. 21	5.00	5.75	+0.75	—1.00	1.75
Platin Rock	2,230	Sept. 28 Oct. 9	Nov. 29 Dec. 2	5.00	5.75	+0.75	—0.50	1.25
Seventy-six Landing	1,700	Oct. 10 Oct. 16	Nov. 20 Nov. 23	4.50	5.75	+1.75	+0.10	1.75
Juden Creek	650	Oct. 18 Oct. 20	Nov. 17 Nov. 19	3.75	6.00	+2.25	+0.70	1.50
Buffalo Island	1,825	Sept. 11 Sept. 23	Nov. 11 Nov. 15	3.75	6.00	+2.25	—1.00	3.25
Total	b 9,345							

Location.	Local gauge at time of—		St. Louis gauge at time of—		Depths in which jetty was placed.
	Placing.	Removal.	Placing.	Removal.	
					Feet.
Riverside	6.8	3.0	6.8	3.1	2-14
Upper Harrisonville Crossing	3.3	3.4	3.5	3.6	3-10
Lower Harrisonville Crossing	3.8	2.8	3.8	2.8	3-10
Platin Rock	3.8	3.3	3.8	3.5	4-12
Seventy-six Landing	5.3	5.4	3.2	3.5	1-10
Juden Creek	5.6	6.3	3.0	3.8	3-12
Buffalo Island	6.0	5.0	4.5	4.0	2- 7

a Out of steamer channel, special work.
b Placed, removed, repaired, and cared for at $3.10 per linear foot.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT UNITED STATES SUPPLY DEPOT.

ST. LOUIS, MO., *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operations at the supply depot during the fiscal year ending June 30, 1898:

The employees on the work at the beginning of the fiscal year included 20 carpenters, 4 machinists, and 25 laborers. This force was increased temporarily as the work required, especially while the plant was being prepared for service during the spring, and at the close of the year included 9 machinists, 35 carpenters, and 70 laborers.

The work done is divided, as heretofore, between construction, equipping for service, extraordinary repairs, and ordinary repairs, the latter including watching, care of property, and handling material and supplies.

CONSTRUCTION.

Portable buildings.—A temporary building 20 feet wide by 97½ feet long was built on Barge No. 6 as kitchen and quarters for 50 men, and another 20 feet by 60 feet for use as a tool room at Little Rock Quarry.

Tools and appliances.—Tools of various kinds were made as required for use, mostly those of special patterns or of extra strength, which cost less to construct than to purchase. The tools made include 115 blocks, all with very heavy straps and pins, 100 stage plank, 14 stone boxes with trucks, 2 hose expanders, 3 engine covers, and a large number of patterns for iron and bronze castings.

Derricks.—Two derricks for unloading stone were set up on Barge No. 103. They have masts 45 feet high, 61-foot booms, and 55-foot stiff legs, all of cypress pile timber. The boilers of two, of the locomotive type, taken from drivers Nos. 7 and 19, set side by side in the middle of the barge, connected so as to require but one heater and feed pump. The hoists are two of the new double-drum engines, with 7 by 10 cylinders.

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Boarding outfit.—One ice chest was made for the quarters on Barge No. 6; 17 oil tanks, 8 laundry boxes, and 6 tables were constructed for use on quarter boats and dredges.

Material—Clevises.—The clevises required were made for use on the construction works; 244 were forged at a cost of about 40 cents each for labor and material. The use of the steam hammer reduced the cost of fabrication about 10 cents for each clevis, bringing it below the lowest bid ever obtained on these articles.

EQUIPPING FOR SERVICE.

Dredge No. 3.—This dredge was landed at the depot on February 26, and remained here until the close of the year.

A large number of small changes were made, and the equipment found desirable in the trial trip was added.

The following are the most important of the changes and additions made:

A traveling carriage was built in the engine room, running both athwartships and fore and aft on iron beams, so that the parts of the main pumps and engines can be lifted out and moved by chain blocks without setting up sheers or supports.

A shifting gear was made for the winch engines, so that both can be handled at the same time by one operator.

The blow-off pipes were provided with an extra valve.

The large jet pumps were connected with the fire hose.

The donkey boiler was supplied with a feed pump and heater.

A brass top was put on the winch-deck railing. A nosing of 2-inch half-round iron was placed across the head to prevent the cutting of lines. Iron jackets were placed around the chimney casings, and the space between them and the casings filled with mineral wool.

Additional chains and blocks were made for holding the suction pipes.

A countershaft was put up in the machine shop to change the location of the driving belt.

A wedge ring was fitted to each discharge pipe near the swivel joint to change its direction.

A line of speaking tube was put up on each side from the forward deck to the stern, and others connecting the engine room with the boiler room and forward deck.

Small changes were made in the ice room to increase its efficiency.

The cabin stairs were moved and small lockers placed in the two forward rooms. The ceiling was removed, so that the kitchen extended up to take in the transoms, and a third tier of iron beds was placed in the crew's room.

A new hood was made for the blower and its speed increased by a larger pulley on the countershaft.

A lighter set of run boards was made for the pipe line and shorter pins for the couplings.

The pontoons were all loaded upon barges. To increase their buoyancy and stability, iron wing boxes or compartments were bolted to each side, increasing the width of the pontoon from 8 to 14 feet. These boxes were made of $\frac{3}{16}$-inch iron, with frames of 2-inch by 2-inch by $\frac{1}{4}$-inch iron, riveted cold and calked with a pneumatic tool. They were each fastened to the pontoons with bolts, made water-tight with rubber washers.

The 40 pontoons of dredge No. 3 were enlarged in this way and work was begun upon those of No. 4.

Dredge No. 4.—The same changes and alterations were made as on No. 3, except that the forward stairway, kitchen bulkhead, and blow-off pipe were arranged as desired by the contractor while being built.

Barges.—The new barges received during the spring, Nos. 201 to 210, 213, and 215, were all equipped with iron pumps made of 3½-inch pipe.

Supply depot.—An air compressor with two 8-inch by 8-inch cylinders was set up and connected for use with pneumatic tools. A boiler in the yard was used as a reservoir, holding air at 125 pounds pressure, which was cut down by a reducing valve to about 80 pounds for drills and 40 pounds for calking tools.

An oil furnace was built for heating large plates of iron and steel. It was 5 feet by 16 feet inside, with the door on one end and a stack 30 feet high at the other, equipped with six burners run by a steam blast at 100 pounds pressure.

The steam is taken from the machine-shop boiler through 800 feet of pipe, and the supply was passed through the furnace to vaporize the water in the supply pipe and superheat the steam.

It works very well as arranged and was used in bending model plates for the snag boat *J. N. Macomb*, iron frames for pontoons, and other large forgings required.

EXTRAORDINARY REPAIRS.

Tenders.—Tender No. 4 was pulled out on the ways during the fall and No. 3 in the spring. Both were extensively repaired, about the same amount of work being done on each.

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All the side and knuckle plank, the top timbers and many of the floors, the entire head, deck frame, wheel, and cylinder timbers, were removed, the furnace rebuilt, the machinery repaired, and the cabin painted.

The new work is of a better material than the old and of the same description, except the deck beams under the boiler stands, which are of 5-inch I beams, and the head, which was strengthened with two 7-inch channels riveted back to back, bent around the bow, and filled with 4 by 7 inch oak nosing. Two of the outriggers were also made of 5-inch I beams.

The gunwales and cylinder timbers of tender No. 1 were torn out and replaced with new.

Barges.—The extensive repairs upon the 13 barges, Nos. 101 to 113, built by contract during 1891, were completed.

Nos. 101, 103, 104, 110, and 111 were repaired during the year, the other barges of this lot having been rebuilt in various years.

The work done was about the same on all these barges and included the renewal of all parts of the barge except the bottom plank, bulkheads, stanchions, breast hooks, and main keelson.

No. 112 was pulled out and the deck frame renewed, the other work having been done in 1895.

The next lot of barges purchased, Nos. 114 to 126, are in bad condition, and many of them need repairs now. Nos. 118 and 119 are unserviceable and have been pulled out and blocked up.

Derrick boats.—Derrick boat No. 1 was pulled out and remained on the ways during the winter.

The gunwales were renewed, the machinery repaired, and an iron derrick made like that on No. 2, except that the sheer legs are of 6-inch extra strong pipe, and not of 5-inch pipe, as on No. 2.

ORDINARY REPAIRS.

Steamer Gen. H. L. Abbot.—The rudders were taken out during the fall, one blade renewed, the other repaired, and the wooden stocks replaced with pipe 15 inches diameter and ⅝ inch thick, of flange steel. One of the tillers was also renewed during the spring. The copper goose neck between the steam drums, which had been found too weak to resist the steam pressure, was replaced during the winter by a telescope joint of 6-inch extra strong pipe. A set of bronze packing rings, with babbitted recesses, was turned and fitted to the cylinders. The furnace was repaired, the crew's room enlarged by the removal of the ice chest to ice room, the old wooden bunks were torn out and replaced with iron beds, new canvas was placed on the roof, the doors and windows were fitted with wire screens, the front cabin and crew's room were painted.

Steamer Gen. T. L. Casey.—The iron spuds were taken down and straightened twice during the fall, new scale pans were made for the boilers, new blow-off pipes for the mud drums, the furnace walls were relaid, and the roof painted. The boat was towed to the depot in the spring and again repaired. The head was repaired, the crew's room enlarged by moving the refrigerator into the ice room, the old bunks were torn out and replaced with iron beds, the furnace was relaid, and the engine room and crew's room painted.

Steamer Gen. Gillmore.—A pair of derrick masts and wooden spuds, 16 inches diameter, were set up on the forecastle during the fall season. The furnace walls were relaid, and a crack in one of the boilers was repaired with a horseshoe patch. The boat was brought to the depot during the spring and remained here until the end of the year.

The boilers and both mud drums were patched, the beams and floors under the boilers renewed, the furnace relaid, new packing rings made for the starboard engine; the heater and machinery was repaired. The wooden bunks were replaced with iron beds, the crew's room and engine room painted, and the wheel repaired.

Pieces were cut from each of the boilers near the water line which were but 0.24 inch thick. They were tested by the boiler inspector and found to be of such a tensile strength that the boat can only carry about 145 pounds of steam.

Dredge No. 1.—Four pairs of bronze sleeves were cast and fitted to the main pump shafts, and two supporting chains were made for the suctions.

Dredge No. 2.—Four nozzles of boiler steel, with openings 4 by 18 inches, and two bellows joints were made and fitted to the suction pipe.

The cast-iron flange coupling on the pump shaft was broken in September, and the key seats in the shaft so worn as to be unserviceable. A new shaft of open-hearth steel was turned and fitted to the forged coupling with new bronze sleeves for the bearing. This was used for about six weeks, but was badly worn in the bearing, and was then spoiled by the breaking of the coupling. The old shaft received with the pump was then reforged and fitted to a new runner or disk with a new forged coupling. These remained in good condition to the end of the season,

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but to avoid delay in case of breakage a new shaft of steel, as hard as could be worked, was made with a cast-steel coupling, and three bronze sleeves, each in two parts, were prepared for the bearing.

Tenders.—Nos. 1 and 2, which were on the ways at the beginning of the half year, were calked and launched in July, and again pulled out for the winter in November, remaining on the ways until the close of the year.

The furnace walls of No. 3 were relaid and the head and floor timbers repaired.

No. 5 was docked in July and repairs made upon the hull and machinery, and repairs were also made upon the head during the spring.

The top sides and outriggers of Nos. 3 to 7 were calked and repaired during the year.

Barges.—The top sides of all the barges in service were calked during the fall, and again in the spring. Small repairs were also made upon their kevels and timber heads.

A break in the side of No. 119 was repaired with 17 new side planks.

Quarter barges.—A set of temporary quarters for 50 men was set up on Barge No. 6.

The roofs of the buildings on Nos. 11 and 28 were covered with new canvas, and the deck of No. 25 was sheathed with 2-inch plank.

The ice rooms on Nos. 11 and 28 were doubled in size, so as to hold 60,000 pounds of ice.

The top sides of all the quarter barges, Nos. 4, 6, 9, 11, 28, and 29, were calked in the fall and spring.

Quarter boats.—The iron beds set up on Nos. 4 to 7 in the spring of 1897 were found so satisfactory that angle iron and wire springs were bought with which to make beds for replacing all the wooden bunks in service. A part of the iron beds were prepared for setting up during the winter, and the remainder were made as needed. Those bought in 1897 cost $2.69 each, while the material cost but $1.65 per bed. Eight hundred were made during the year, of which 567 were set up.

The cost of construction was found to be as follows:

Shearing	$0.02
Forging	.11
Marking	.07
Punching	.09
Riveting	.14
Stretching	.08
Painting	.50
Total cost of labor	1.01

The entire cost of a bed ready to set up was $2.66, or a little less than the cost of those purchased.

The above price for painting, however, is the cost of three coats of lead and one of white enamel, all applied by hand, making a much better and more durable cover than the single black dip used on the beds purchased.

Seventeen of the beds made were set up in the crew's room of the steamer *Gen. Gillmore*, the same number on the *Casey*, and 18 on the *Abbott*, 4 on each of Dredges Nos. 3 and 4, 133 on each of the Quarter Boats Nos. 2, 3, and 8, and 108 on No. 1, the boat used by the brush force. Enough are now on hand to equip Nos. 9 and 10.

The upper guards of boats Nos. 1, 2, 3, and 8 were extended around the end of the stairways, most of the guards renewed, the bulkheads shifted below to enlarge the size of the kitchen and storeroom, and the entire cabin was painted two coats inside and out.

The sink and hot-water heater were set up on each of the above and also on Nos. 5 and 7.

A bow dock was placed under each end of Nos. 1, 2, 3, 5, and 8, and the rakes renewed. The roofs of Nos. 7 and 8 were covered with new canvas, and that on Nos. 1, 2, 3, and 5 were painted.

The lower guards of Nos. 1, 2, and 3 were renewed, and the rake and side seams of Nos. 1 to 10 calked in the fall and spring.

Office and survey boats.—The side and rake seams of Nos. 1 to 4 were calked in the fall and spring. The inside of the cabins of Nos. 1 and 2 was painted two coats during the winter and spring.

Pile drivers.—The iron leads on Nos. 13, 14, 25, 26, and 29 became unserviceable during the fall and were replaced with 8 by 12 inch yellow pine. The wooden leads on Nos. 22, 24, 31, and 35 were repaired. The roofs of Nos. 13, 16, 18, 19, 21, 22, 25, and 29 were covered with new canvas. The leads, sills, braces, and furnaces of Nos. 17, 23, 24, 25, 31, and 35 were repaired during the year.

Nos. 8, 11, 16, 18, and 21 were pulled out in November, that needed repairs might be made upon the hulls, and the leads of Nos. 11, 16, and 18 taken down.

The boilers were removed from Nos. 7 and 19 to Barge No. 103 for use with derricks.

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Pile Driver No. 13 was equipped during the fall with a derrick and spuds for unloading stone. The boom was 54 feet long, and the spuds were fastened to a mast on each side near the derrick end.

The drivers now in a serviceable condition with hoisting engines and marine boilers are Nos. 1 to 6, 9, 12, 14, and 22 to 35—23 in all; but Nos. 13 and 17, now with derricks, could be soon prepared for use as drivers, if desired.

The 3 other drivers, with marine boilers Nos. 16, 18, and 21, require new gunwales and leads to fit them for service.

Small boats.—All but 24 of the 127 flats on the bank July 1 were repaired, calked, and launched during the summer. One hundred and eighty-three flats were returned from the works at the close of the season and pulled out for the winter. Eighty-five of these were repaired, calked, and launched in the spring. Many of the flats, especially those built of Oregon fir, are in bad condition, and some, probably about 30, are not worth repairing. It would be more advantageous to the Department to replace them with new than to rebuild them. Sixty-two skiffs and 6 yawls were repaired in the fall and 33 skiffs and 9 yawls in the spring.

Portable buildings.—The canvas roofs of 16 sections at the depot and 6 sections on Barge No. 25 were renewed and painted.

Portable jetties.—All of the serviceable gates, 824 in number, were loaded upon barges and sent out for use in September. Seven hundred and ninety-three were turned in at the close of the season and piled on the bank. About 750 are now in good condition and will be available for use another season.

Ways.—Small repairs were made upon the ways, and the mud was washed from their outer ends after each rise in the river.

Portions of the ways are in bad condition, but by renewing the tilting table and making small repairs on the other portions the ways can be used another year.

No plant will need docking within a year that can not be pulled on the ways in their present condition.

The quarter boats are being repaired with the bow dock so as to last at least two years.

The plant pulled out on the ways during the year included 4 tenders, 1 derrick boat, 6 pile drivers, and 8 barges.

Supply depot.—The temporary building used as a junk house was found to be in bad condition, and was rebuilt above the platform east of the wall. It was set on piles above high water and the space underneath can be used for storing barrows, etc.

A temporary building 14 by 30 feet was put up alongside the machine shop to carry a planer and radial drill.

A temporary building about 16 feet square was set up south of the pipe shop for use as a foundry, in which castings of brass and bronze are made as required. The furnace used is connected with the blower, and castings are made as heavy as 100 pounds each.

The iron lumber shed was extended 80 feet to the north. It was built 45 feet wide of the material taken from unserviceable portable jetties.

Tools and appliances.—Tools of all kinds were repaired as needed here and at the construction works below. This work includes repairs to 2 steam drills, which were rebored and supplied with new valves, springs, buffers, etc., the overhauling of 4 jet pumps, the repairing of 2 hand punches and 1 shear, the turning of a large number of punches, dies, etc.

Surveys.—A shanty 13 by 30 feet was set up and equipped on a flat for the use of a small survey party. Signal poles, water gauges, telemeter rods, and penalty boards were made for use in the field.

Materials.—The supplies of all kinds received here were handled, stored, and shipped as required.

Very respectfully, your obedient servant,

C. D. LAMB, *Superintendent.*

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

Y 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

St. Louis Harbor has a length of about 18 miles, being divided into two nearly equal parts by the Eads Bridge. The upper portion of the harbor, between the bridge and the northern limits of the city, is about 10 miles in length. About 3 miles above the Eads Bridge is the Merchants Bridge. The lower portion of the harbor, included between the

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Eads Bridge and the River Des Peres, is about 8 miles long. A good depth of water and accessible landings exist in this lower part of the harbor, and a sufficient depth is found above the Merchants Bridge.

Between the Merchants and Eads bridges there had existed for a considerable number of years middle bars, and also shoals near the Illinois shore, which interfered with navigation and which will be mentioned again further on.

Appropriations for improvement of St. Louis Harbor had been made as early as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work done in later years by the United States consisted in the building of stone and brush dikes generally normal to the direction of the current, in the closing of Cahokia Chute, and the protection of the bank in Sawyer Bend.

The river and harbor act of Congress approved September 19, 1890, contained an appropriation of $182,000 for improving harbor at St. Louis, Mo., and the officer in charge, in submitting a project for its expenditure, recommended that the money be applied to the portion of the harbor between the Eads and Merchants bridges. The approved project consisted in contracting this portion of the river to a width of about 2,000 feet by means of a system of hurdles built along the Illinois shore for a distance of about 13,000 feet, with a view to removing the bars which then existed and which interfered with navigation at low stages of the river, and also to improve the ferry landings on the Illinois shore. The object of the hurdles was to cause deposits of sediment, and thus build up a new bank out to the line desired. They were twelve in number and spaced 1,000 feet apart. The hurdles, which were completed by July 1, 1892, were from 325 to 2,075 feet long. A full description of the manner of doing this work, and the results obtained, have been given in previous annual reports.

The navigable depth in the channel of the harbor between the line of hurdles and the opposite wharf line of St. Louis was, in December, 1893, 11 feet, the river standing at zero of the gauge, which is 4 feet below standard low water.

The amount expended to June 30, 1897, was $150,762.03. There were no expenditures during the last fiscal year.

The hurdles remain in fair condition, except that the extreme river ends are weakened each year by drift and gradual decay of the pile timber. Repairs will be needed shortly.

The balance, $31,237.97, remaining from the appropriation of 1890, has been reserved to repair damages that may occur to the hurdles and to extend them when necessary.

No further appropriation is asked for this work.

The commercial statistics pertaining to this portion of the river will be found in the report on the improvement of the Mississippi River between the mouth of the Ohio and the mouth of the Missouri rivers.

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ending June 30, 1898, amounted to $1,000,632.43.

The amount of internal revenue collected was $8,394,365.65.

Money statement.

July 1, 1897, balance unexpended	$31,237.97
July 1, 1898, balance unexpended	31,237.97

Appropriation.

By act of September 19, 1890	$182,000

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Y 4.

TO PREVENT THE MISSISSIPPI RIVER FROM BREAKING THROUGH INTO THE CACHE RIVER AT OR NEAR A POINT KNOWN AS BEECHRIDGE, A FEW MILES ABOVE CAIRO, ILL.

The sundry civil act approved June 4, 1897, contains an item providing for this work, which reads as follows:

For the purpose of preventing the Mississippi River from breaking through into the Cache River at or near a point known as Beechridge, a few miles north of Cairo, whereby the national cemetery at Mound City, at the mouth of the Cache River, and the marine hospital at Cairo would be in imminent danger of destruction, the sum of one hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be immediately available.

The project for this work not being based upon a survey under the Engineer Department, and the extent of the work contemplated not being known, an estimate of its total cost can not be given. From a study of the conditions involved, it would seem that the object of the appropriation can best be carried out by revetting as great a length of the bank of the Mississippi River in the vicinity of Beechridge railroad station as the funds will suffice.

The project for the expenditure of the amount appropriated contemplates commencing at a suitable point on the bank of the river a short distance above the nearest point to Beechridge station, building a short hurdle out into the stream to protect the head of the revetment, and then revetting the bank in the usual manner down as far as the funds will suffice. Under this project a hurdle 275 feet in length was constructed, 8,250 linear feet of low-water revetment and 3,375 linear feet revetted to a 30-foot stage, 4,875 feet to stages varying from 30 to 10 feet. The low-water revetment was about 130 feet in width, extending from the low-water line out into the river. Four hundred and forty feet of the upper portion of this was made of brush and the remainder of lumber about 1 inch thick, from 4 to 6 inches wide, and 12 feet in length. This was woven in and out similar in manner to using the brush. It makes an excellent mattress when used in this way.

After the high water had graded the bank back, the upper revetment of stone was put on.

The work is being done by purchase of material in open market and hired labor, using Government plant belonging to the general improvement of the river between the mouth of the Missouri River and the mouth of the Ohio River.

The location of the revetment is shown on Plate No. VI, herewith transmitted.

A survey was made of Greenleaf Bend in the Mississippi River, and Cache River from this vicinity to its mouth on the Ohio River near Mound City, Ill.

The funds available will be sufficient to complete, including work already done, about 10,000 feet of revetment to a height of about the 30-foot stage.

Money statement.

July 1, 1897, balance unexpended	$100,000.00
June 30, 1898, amount expended during fiscal year	33,427.70
July 1, 1898, balance unexpended	66,572.30
July 1, 1898, outstanding liabilities	3,385.75
July 1, 1898, balance available	63,186.55

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APPENDIX Z.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL, AND OF GALENA RIVER, ILLINOIS.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE LIEUT. COL. W. R. KING AND CAPT. C. McD. TOWNSEND, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Operating snag boats and dredge boats on Upper Mississippi River.
2. Mississippi River between Missouri River and St. Paul.
3. Operating and care of Des Moines Rapids Canal and Dry Dock.
4. Operating and care of Galena River improvement, Illinois.

HARBOR LINES.

5. Davenport, Iowa.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 20, 1898.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1898. Lieut. Col. W. R. King, Corps of Engineers, was in charge of this district until his death, May 18, 1898.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Z 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work performed under this appropriation consists in the removal of snags, wrecks, rocks, and similar obstructions to navigation. The operations extend from Minneapolis to the mouth of the Missouri River—a distance of about 724 miles.

The plant belonging to the work consists of the snag boats *General Barnard* and *J. G. Parke*, but dredges, drill boats, and tenders are borrowed from other appropriations when required. The snag boats were built in 1879 and 1882. The general improvement of the river has, however, so reduced the number of caving banks that for several years but one snag boat has been required, and the *J. G. Parke* has been

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employed as a tow boat. The *General Barnard* can now be economically replaced by a smaller boat.

During the past year the snag boat *General Barnard* was engaged in the work of removing snags, etc., from July 1 to November 12, 1897, and from April 24 to June 30, 1898. Dredge *Phœnix* and tender were employed from July 17 to November 13, 1897, in removing a small island near Turners Landing, in dredging a basin for a winter harbor near Portage des Sioux for the Government plant, and in excavating broken rock in vicinity of Gregory and Keokuk.

Drill boat No. 6 and tender operated during the entire month of June, 1898, in breaking up, by blasting, certain ledges or patches of rock in mid-channel near the mouth of Henderson River.

The details of work accomplished are given in the appended report of Assistant Engineer C. W. Durham.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of the Missouri River for the calendar year 1897 was, approximately, 3,200,000 tons. This includes logs and lumber.

Money statement.

June 30, 1898, amount drawn from Treasury under permanent appropriation	$25,000.00
June 30, 1898, amount expended during fiscal year	25,000.00
July 1, 1898, amount available under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1899	25,000.00

Abstract of appropriations and allotments.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
June 30, 1893	25,000
June 30, 1894	25,000
June 30, 1895	25,000
June 30, 1896	25,000
June 30, 1897	25,000
June 30, 1898	25,000
Total	774,640

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1897 to about 50 towboats, valued at $500,000. Along

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the river from Minneapolis to St. Louis 80 sawmills were operated by 65 wholesale lumber firms, having an invested capital of about $45,000,000. Their manufactures in 1897 were: Lumber, 1,303,450,000 feet B. M.; shingles, 364,117,000; laths, 247,789,000. In addition to the manufacturers, there is a large number of retail or distributing firms.

Lumber manufacture, Upper Mississippi River Valley, 1897.

[Value about $32,000,000.]

Locality.	Lumber.	Shingles.
	Feet B. M.	*Number.*
Above Minneapolis	294,070,000	58,034,000
Minneapolis	460,348,000	93,512,000
St. Paul to St. Louis	686,545,000	213,765,000
St. Croix River	210,060,000	49,361,000
Black River	167,455,000	65,943,000
Chippewa River	274,879,000	138,382,000
	2,093,357,000	618,997,000

The larger part of the above was floated for greater or less distance on the Mississippi River, either as logs or lumber. The total product (excluding shingles and laths), if shipped by rail, would have loaded 174,446 cars of 12,000 feet each (about 20 tons)—the quantity generally accepted as a carload. Supposing an average length of car of 35 feet, it would have loaded a train 1,156 miles in length, or 8,722 trains of 20 cars each.

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1897.

Locality.	Lumber.	Shingles.	Laths.
	Feet B. M.	*Number.*	*Number.*
Minneapolis	460,348,000	93,512,000	67,209,000
Hastings	8,000,000	3,000,000	1,000,000
Redwing	10,263,000	3,500,000	1,789,000
Winona	125,651,000	66,636,000	50,037,000
La Crosse	156,557,000	57,340,000	22,166,000
Guttenberg	11,500,000	3,500,000	1,000,000
Dubuque	44,000,000	11,000,000	8,000,000
Bellevue	6,000,000	.....	2,000,000
Lyons	15,000,000	5,659,000	3,091,000
Clinton	88,125,000	12,633,000	11,965,000
Fulton	15,500,000	3,432,000	2,682,000
Moline	25,000,000	4,107,000	4,819,000
Davenport	40,950,000	6,275,000	7,300,000
Rock Island	115,000,000	23,000,000	26,500,000
Muscatine	82,156,000	20,865,000	18,574,000
Burlington	30,000,000	9,000,000	5,000,000
Fort Madison	16,400,000	12,658,000	3,657,000
Keokuk	12,000,000	.....	.....
Quincy	18,000,000	15,000,000	6,000,000
Hannibal	23,000,000	13,000,000	5,000,000
Total	1,303,450,000	364,117,000	247,789,000

Lumber manufacture on the Mississippi River from St. Paul to St. Louis for ten years.

Year.	Lumber.	Shingles.	Laths.
	Feet B. M.	*Number.*	*Number.*
1897	843,102,000	270,605,000	180,580,000
1896	648,408,000	167,392,000	127,732,000
1895	870,299,000	278,420,000	185,616,000
1894	673,572,000	204,198,000	158,586,000
1893	811,576,588	285,897,000	190,394,800
1892	931,806,305	357,014,775	228,042,910
1891	814,228,707	332,666,750	207,722,350
1890	1,231,678,960	508,986,705	.....
1889	1,044,555,298	463,132,700	.....
1888	1,048,951,386	423,655,050	.....
Total	8,918,178,244	3,291,967,980	.....

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Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, and the Joy Lumber Line. There are also many independent boats carrying freight and passengers. During the season of 1897 the amount of freight and number of passengers carried could not be accurately ascertained, but partial reports give 128,970 tons of freight and 201,685 passengers, not including those of ferry and excursion boats.

Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1897 was, approximately, 3,200,000 tons.

Statement of approximate tonnage of the Upper Mississippi River, Minneapolis to St. Louis, for ten years.

Year.	Tons.	Year.	Tons.
1888	3,750,000	1893 *b*	3,200,000
1889	3,500,000	1894 *a*	2,975,000
1890	4,200,000	1895 *a*	3,000,000
1891 *a*	3,300,000	1896 *b*	2,250,000
1892	3,750,000	1897	3,200,000

a Very low water. *b* Great business depression.

At St. Louis there were received in 1897 from the Upper Mississippi River, by boats, barges, and rafts, 51,435 tons merchandise, 46,297,300 feet B. M. pine lumber, 16,584,000 shingles, and 9,667,350 laths. There were shipped to points on the Upper Mississippi River 36,225 tons merchandise.

Arrivals and departures from St. Louis during 1897.

Steamboats and barges from Upper Mississippi River arrived at St. Louis..... 561
Steamboats and barges departed from St. Louis for Upper Mississippi River.... 546

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

List of steamboats, barges, and rafts passing through various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1897.	1896.	1895.	1897.	1896.	1895.	1897.	1896.	1895.
Hastings	967	534	726	478	147	693	239	166	146
Winona	3,985	3,329	3,745	1,330	925	1,444	1,287	1,098	1,325
La Crosse	3,198	2,608	2,822	912	977	955	915	739	1,085
Dubuque	1,694	1,268	1,358	1,248	882	977	543	428	406
Sabula	1,904	1,604	1,576	1,016	477	1,078	(*a*)	(*a*)	(*a*)
Clinton	3,289	2,793	2,308	693	370	467	*b* 292	*b* 166	501
Rock Island	3,525	2,836	2,930	729	425	821	524	356	564
Keithsburg	899	732	996	245	158	440	201	180	*b* 180
Burlington	2,002	1,589	1,645	1,704	515	692	168	313	336
Fort Madison	1,374	1,221	1,473	690	434	437	159	145	227
Keokuk	1,628	1,543	1,317	691	1,269	519	101	97	119
Quincy	1,571	1,396	1,787	576	458	488	123	111	122
Hannibal	1,272	987	1,381	666	498	1,447	170	129	372
Louisiana	874	652	1,008	562	323	745	34	28	34
Alton	1,665	.....	.....	689	.....	.....	27	.....	.....

a No record. *b* Partial record.

The following table shows the navigation during a period of twenty years through Winona Bridge, at which point the traffic is largest:

Statement of steamers, barges, and rafts passing Winona Bridge during twenty years.

Year.	Steamboats.	Barges.	Rafts.	Year.	Steamboats.	Barges.	Rafts.
1878	2,948	1,115	863	1888	4,740	684	1,894
1879	3,760	1,362	1,889	1889	4,419	1,140	1,387
1880	4,593	883	1,392	1890	5,417	1,045	2,123
1881	4,739	575	1,717	1891	3,687	1,108	1,495
1882	5,627	942	1,939	1892	5,268	957	1,759
1883	4,893	828	1,352	1893	4,428	1,324	1,655
1884	4,992	905	2,007	1894	3,715	1,422	1,172
1885	5,126	848	1,973	1895	3,745	1,444	1,325
1886	4,570	974	1,860	1896	3,329	925	1,098
1887	4,309	1,600	1,100	1897	3,985	1,330	1,287

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Internal revenue for the year ending December 31, 1897, collected in districts bordering on the Upper Mississippi River.

Locality.	Office.	Amount.
Minnesota	St. Paul	$1,718,685.43
Second Wisconsin	Madison	493,904.87
Third Iowa	Dubuque	179,254.49
Fourth Iowa	Burlington	289,871.46
Fifth Illinois	Peoria	19,105,595.16
Eighth Illinois	Springfield	9,626,254.90
Thirteenth Illinois	East St. Louis	699,373.47
First Missouri	St. Louis	7,271,984.99
Total		39,385,014.77

Customs revenue and tonnage for the year ending December 31, 1897.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Paul, Minn	$207,206.00	2,035.70	26
La Crosse, Wis	13.57	4,913.70	68
Dubuque, Iowa	12,295.88	6,026.52	20
Rock Island, Ill		7,637.13	77
Burlington, Iowa	31.22	1,477.11	15
St. Louis, Mo. *a*	1,047,773.23	115,837.50	203
Total	1,267,319.90	137,927.66	409

a Only a part of the St. Louis statement is applicable to the Upper Mississippi.

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	July, 1897.							
1	J. Siegrist	$8.25			$8.25			
2	Louis Weckel	18.81			18.81			
3	E. Fritz	9.18			9.18			
4	H. J. Forschler	7.45			7.45			
5	J. H. Scrogum	9.27			9.27			
6	Wm. A. Sutor	3.30					$3.30	
7	J. McCaffrey	176.26				$176.26		
8	H. Schroeder	23.34			23.34			
9	F. W. Luley & Son	18.71			18.71			
10	Michaud Bros	13.60			13.00		.60	
11	H. J. Forschler	1.70					1.70	
12	Fred Kroner Hardware Co	2.00					2.00	
13	Bergoust Grocery Co	12.47			12.47			
14	E. Fritz	20.25			20.25			
	Total	324.59			140.73	176.26	7.60	
	August, 1897.							
1	Hired men	737.00		$737.00				
2	....do	1,198.33	$75.00	1,123.33				
3	J. McCaffrey	163.10				163.10		
4	C. E. Macy	143.00				143.00		
5	Wm. A. Sutor	82.50				82.50		
6	Gentskow Bros	49.50				49.50		
7	John B. Flick	8.06			8.06			
8	H. Schroeder	18.25			18.25			
9	Louis Weckel	24.35			24.35			
10	Henry Dart's Sons	112.58			108.98		3.60	
11	Kellenberger & Co	36.87			32.32		4.55	
12	The Kirsch Co	47.32			47.32			
13	Alton Novelty Mfg. Co	23.46					23.46	
14	Osgood Dredge Co	10.00						$10.00
15	Adams Express Co	.75					.75	
16	The Kirsch Co	21.60			21.60			

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	August, 1897—Continued.							
17	Miss. Coal and Ice Co	$76.00				$76.00		
18	Eagle Boat Store Co	69.18					$69.18	
19	C. P. Comegys	8.25	$8.25					
20	Whitebreast Fuel Co	79.46				79.46		
21	Kellenberger & Co	72.06			$67.66		4.40	
22	H. K. Johnston Hardware Co.	47.47					46.47	$1.00
23	Adams Express Co	1.40					1.40	
24	A. Weber Co	15.29						15.29
25	Hired men	1,214.00		$1,214.00				
	Total	4,259.78	83.25	3,074.33	328.54	593.56	153.81	26.29
	September, 1897.							
1	Hired men	70.56						70.56
2	do	1,197.34	75.00	1,122.34				
3	John McCaffrey	198.10				198.10		
4	John Siegrist	5.50			5.50			
5	McIntosh & Jones	16.97			16.87		.10	
6	Hess Bros	23.83			23.83			
7	H. Schroeder	18.73			18.73			
8	J. H. Scrogum	4.92			4.92			
9	J. Kieffer	25.32			25.32			
10	Kellenberger & Co	25.79			23.79		2.00	
11	The Kirsch Co	109.92			109.92			
12	Elihu Elliot	8.89			8.89			
13	William Schnippe	161.25				161.25		
14	Geo. D. Hayden Machine Co	7.77						7.77
15	L. M. Rumsey Mfg. Co	19.00					19.00	
16	McElroy Iron Works Co	5.00						5.00
17	Quincy Boiler Co	5.00						5.00
18	Adams Express Co	.45	.45					
19	Whitebreat Fuel Co	21.93				21.93		
	Total	1,926.27	75.45	1,122.34	237.77	381.28	21.10	88.33
	October, 1897.							
1	Hired men	65.45						65.45
2	do	1,185.50		1,185.50				
3	do	1,200.00	75.00	1,125.00				
4	Alton Coal and Ice Co	128.65				128.65		
5	H. K. Johnston Hardware Co.	5.90					5.90	
6	Poplar Bluff Lumber Co	91.61						91.61
7	Wilkinson & Co	1.25						1.25
8	A. Weber Co	2.34						2.34
9	Jehlen Bros	20.77			20.77			
10	Hess Bros	24.93			24.93			
11	H. J. Forschler	13.38			13.38			
12	Wm. A. Sutor	104.75			4.50	100.25		
13	C. E. Macy	102.00				102.00		
14	S. W. Vanderwarker	37.85				37.85		
15	Gentskow Bros	28.00				28.00		
16	Fred Kroner Hardware Co	3.58					3.58	
17	McElroy Iron Works Co	9.60						9.60
18	Buck-Reiner Co	71.77			69.17		2.60	
19	D. Santo	66.92			66.92			
20	T. Nodler	22.20			22.20			
21	J. Kieffer	21.06			21.06			
22	White & Co	11.73			11.73			
23	Hess Bros	16.50			16.50			
24	H. Schroeder	34.41			34.41			
25	W. H. Pape	15.00				15.00		
26	John McCaffrey	192.36				192.36		
27	C. E. Macy	75.00				75.00		
28	C. G. Hartin	126.00				126.00		
29	M. Meigs	29.00					29.00	
30	The Sovereign Lubricating Co	5.30					5.30	
31	Standard Oil Co	4.99					4.99	
32	Whitebreast Fuel Co	222.85				222.85		
33	Laflin Rand Powder Co	9.05					9.05	
34	Kollmyer & Talbot	14.39						14.39
35	C. W. Durham	5.75	5.75					

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	October, 1897—Continued.							
36	Alton Coal and Ice Co	$58.48				$58.48		
37	Miss. Coal and Ice Co	38.00				38.00		
38	J. Siegrist	5.50			$5.50			
39	Chas. J. Long	27.08			27.08			
40	Jno. Lowell	27.43			27.43			
41	Jacob Stocke	21.59			21.59			
42	Henry Dart's Sons	28.19			18.20		$9.99	
43	A. Weber Co	13.04						$13.04
	Total	4,189.15	$80.75	$2,310.50	405.37	1,124.44	70.41	197.68
	November, 1897.							
1	Hired men	1,145.83		1,145.83				
2	do	75.56						75.56
3	do	1,200.00	75.00	1,125.00				
4	Miss. Coal and Ice Co	38.00				38.00		
5	L. Buchanan	77.40				77.40		
6	Chisholm & Evans Co	36.00				36.00		
7	John McCaffrey	157.78				157.78		
8	Wm. A. Sutor	176.00				176.00		
9	John B. Flick	1.75			1.75			
10	H. J. Forschler	11.00			11.00			
11	E. Fritz	18.90			18.90			
12	D. Santo	78.26			78.26			
13	H. Schroeder	34.92			34.92			
14	do	16.95			16.95			
15	Hess Bros	20.90			20.90			
16	do	21.55			19.65		1.90	
17	T. Nodler	39.40			38.55		.85	
18	Smith Bros	32.61			32.48		.13	
19	Chisholm & Evans Co	74.00				74.00		
20	Hired men	390.33		390.33				
21	John McCaffrey	50.54				50.54		
22	Quincy Coal Co	16.00				16.00		
23	D. Tipton	9.25	9.25					
24	Hired men	54.00		54.00				
25	T. Nodler	23.96			23.96			
26	D. Santo	16.26			16.26			
27	Ellsworth & Rigg	.94					.94	
28	Hired men	585.16		585.16				
	Total	4,403.25	84.25	3,300.32	313.58	625.72	3.82	75.56
	December, 1897.							
1	Hired men	254.00	75.00	179.00				
2	do	77.50						77.50
3	McElroy Iron Works Co	4.99						4.99
	Total	336.49	75.00	179.00				82.49
	January, 1898.							
1	Hired men	59.12						59.12
2	do	290.00	75.00	215.00				
3	McElroy Iron Works Co	5.68						5.68
4	Chas. Delile	1.55	1.55					
5	Seither & Cherry Co	3.58						3.58
6	Hired men	294.75		290.00			4.75	
7	H. B. Martens	10.00						10.00
	Total	664.68	76.55	505.00			4.75	78.38
	February, 1898.							
1	James & Laughlins, limited	23.00						23.00
2	Hired men	290.00		290.00				
3	A. Weber Co	1.25						1.25
4	Ed. Schlotter	17.19						17.19
	Total	331.44		290.00				41.44

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	March, 1898.							
1	Hired men	$420.00	$420.00					
2	....do	290.00		$290.00				
3	A. Weber Co	2.71						$2.71
4	Hired men	84.19						84.19
	Total	796.90	420.00	290.00				86.90
	April, 1898.							
1	F. B. Martin	11.28	11.28					
2	Wilkinson & Co	1.30						1.30
3	Hired men	789.99		789.99				
4	..... do	116.82		116.82				
	Total	869.39	11.28	856.81				1.30
	May, 1898.							
1	J. W. Erman	11.00						11.00
2	Whitebreast Fuel Co	69.60				$69.60		
3	John McCaffrey	134.26				134.26		
4	The Con. Coal Co. of St. Louis	182.00				132.00		
5	Eagle Boat Store Co	61.00					$41.29	19.71
6	Ellsworth & Rigg	6.60						6.60
7	Standard Oil Co	46.45					46.45	
8	Wilkinson & Co	10.10						10.10
9	Miss. Coal and Ice Co	20.50						20.50
10	M. L. Boyles	11.57						11.57
11	Buck-Reiner Co	270.30			$239.15		31.15	
12	Hess Bros	27.75			25.56		2.19	
13	C. Schroeder	17.50			17.50			
14	D. Santo	30.30			30.30			
15	T. Nodler	31.71			31.71			
16	Louis Schaefer	21.64			21.64			
17	John Grundmeyer	18.90			18.90			
18	Jehlen Bros	18.09			18.09			
19	H. J. Forschler	8.69			8.69			
20	J. W. Stewart	3.99					3.99	
21	C. W. Durham	3.00	3.00					
22	D. Tipton	10.06	10.06					
23	Hired men	1,165.00		1,165.00				
24	.....do	15.35						15.35
	Total	2,145.36	13.06	1,165.00	411.54	335.86	125.07	94.83
	June, 1898.							
1	Wm. A. Sutor	66.00				66.00		
2	C. G. Hartin	99.00				99.00		
3	.....do	110.25				110.25		
4	C. E. Macy	220.00				220.00		
5	John McCaffrey	60.41				60.41		
6	Crown Coal and Tow Co	130.00				130.00		
7	H. J. Forschler	22.51			22.26		.25	
8	Hess Brothers	38.40			37.40		1.00	
9	C. Schroeder	19.48			19.48			
10	Bergostt Grocery Co	18.51			18.51			
11	J. H. Scrogum	6.28			6.28			
12	Gentskow Brothers	6.25			6.25			
13	J. Kieffer	33.61			33.61			
14	.....do	16.31			16.31			
15	John Lowell	17.58			17.58			
16	Jacob Stocke	10.83			10.83			
17	E. H. Kortkamp Jewelry Co	5.80					5.80	
18	Herman Rippe	9.75					9.75	
19	T. Nodler	12.62			11.37		1.25	
20	Frank J. Weeks	15.31			15.31			
21	A. J. Stillwell Meat Co	8.00			8.00			
22	Whitebreast Fuel Co. of Ill	6.96				6.96		
23	McElroy Iron Works Co	2.39						2.39
24	Weyerhauser & Denkmann	4.49						4.49
25	J. Siegrist	3.50			3.50			
26	Chas. J. Long	15.26			15.26			

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Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	June, 1898—Continued.							
27	C. Schroeder	$9.35			$9.35			
28	Quincy Coal Co	34.60				$34.60		
29	Hired men	1,163.17		$1,163.17				
30	do	1,282.67		1,282.67				
31	Berderbecke-Miller Co	203.83			184.86		$18.97	
32	Louis Law	53.28			53.28			
33	Rankin & Dodge	19.04			19.04			
34	James S. Klein	17.85			17.85			
35	Burlington Creamery Co	6.30			6.30			
36	J. S. Gilmore	132.68			132.68			
37	H. S. Cable	95.56				95.56		
38	Davis Co	31.93					31.93	
39	Hired men	635.00	$635.00					
40	J. C. McElherne	8.16					8.16	
41	Paridon & Son	68.63						$68.63
42	John McCaffrey	31.15				31.15		
	Total	4,752.70	635.00	2,445.84	665.31	853.93	77.11	75.51

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1898.

Month.	Office expenses, superintendence, and contingencies.	Care, repair, and operating snag boats and dredge boats.						Grand total.
		Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.	
1897.								
July			$140.73	$176.26	$7.60		$324.59	$324.59
August	$83.25	$3,074.33	328.54	593.56	153.81	$26.29	4,176.53	4,259.78
September	75.45	1,122.34	237.77	381.28	21.10	88.33	1,850.82	1,926.27
October	80.75	2,310.50	405.37	1,124.44	70.41	197.68	4,108.40	4,189.15
November	84.25	3,300.32	313.58	625.72	3.82	75.56	4,319.00	4,403.25
December	75.00	179.00				82.49	261.49	336.49
1898.								
January	76.55	505.00			4.75	78.38	588.13	664.68
February		290.00			41.44	331.44	331.44	
March	420.00	290.00			86.90	376.90	796.90	
April	11.28	856.81			1.30	858.11	869.39	
May	13.06	1,165.00	411.54	335.86	125.07	94.83	2,132.30	2,145.36
June	635.00	2,445.84	665.31	853.93	77.11	75.51	4,117.70	4,752.70
Total	1,554.59	15,539.14	2,502.84	4,091.05	463.67	848.71	23,445.41	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1898.

CAPTAIN: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1898.

Operations of snag boat General Barnard.—The *Barnard* was in commission, for the purpose of removing snags and other obstructions between Minneapolis and mouth of Missouri River, from July 1 to November 12, 1897, and from April 24 to June 30, 1898. No special work was done by her in 1897, except the removal of ten large pieces of rock from the landing at Rock Island. During the winter of 1897–98 she lay in the Des Moines Rapids Canal above middle lock, and received small repairs before coming out in the spring.

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Summary of operations of snag boat General Barnard for fiscal year ending June 30, 1898.

Snags removed	154
Leaning trees pulled back	78
Leaning trees felled	3,893
Wrecks removed	3
Cribs removed	1
Rocks removed	10
Buoys placed	83
Ring bolts placed	2
Surveys made (days)	2
Miles run	8,819

Operations of snag boat J. G. Parke.—During the fiscal year the *Parke* was used as a towboat on construction work between the Illinois and Missouri rivers.

Operations of dredge Phœnix and tender.—From July 17 to August 31, 1897, the above plant was engaged in removing a small towhead near Turners Landing, in dredging a basin for a winter harbor at Portage 1,200 feet long, 80 feet wide, and 8 feet deep at low water, and in removing 150 feet of the outer end of the wing dam opposite foot of Piasa Island. In the above work there were 40,743 cubic yards of material dredged, at a cost of $2,838.57. This plant was employed August 31 to November 13, 1897, in removing the rock near Gregorys Landing and opposite Keokuk, shattered by drill boat No. 6 earlier in the season. At Keokuk the area blasted over was 10,752 square feet; at Gregorys Landing, 5,044 square feet. At both places 894 solid cubic yards rock were broken and 6,921 cubic yards of broken rock, sand, and other débris were taken up and removed.

The cost of this work was $3,971.73, but the expenditure prior to July was $5,854.58, making a total of $9,826.31 for the rock excavation at Gregorys Landing and Keokuk.

Operations of drill boat No. 6.—Drill boat No. 6 and tender *Mac* were employed during the entire month of June, 1898, in breaking up, by blasting, certain ledges or patches of rock in midchannel near the mouth of Henderson River. The material was a hard sandstone, and several large bowlders were met with. The area covered by the drill boat was 15,872 square feet, in which 911 holes were drilled and 852 blasted; 2,350 pounds of rackarock were used, resulting in the breaking up of 693 solid cubic yards of rock. It is proposed to remove the broken material by dredge at an early day

The cost of this work to date is $1,860.15.

Summary of expenditures.

Snag boat *General Barnard*	$14,720.12
Dredging at Portage, Turners, and Alton	2,838.57
Rock excavation, Keokuk and Gregorys Landing	4,026.57
Rock excavation near mouth of Henderson River	1,860.15
Superintendence and office	1,554.59
Total	25,000.00

RIVER NOTES.

In 1897 the river was high until July, when it fell gradually, but was never very low during the season. In 1898 the river has remained at a good boating stage to the present time.

Available channel depths, in feet, at the worst bars at low stages in 1897, as found by the snag boat General Barnard.

Between St. Paul and Lake Pepin (61 miles).—The *Barnard* found no bar on which there was not more than 4 feet.

Reeds Landing to Winona (41 miles).—Beef Slough, 4; Rollingstone, 3.5 (later improved).

Winona to Rock Island (277 miles).—Below Comanche, 4.

Rock Island to Des Moines Rapids (118 miles).—Buffalo, 4; Illinois Chute, 4.

Keokuk to Missouri River (184 miles).—Cincinnati Landing, 4; foot of Hickory Chute, 3.5; Thomas Chute, 4; Turners, 3.5.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

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Z 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND ST. PAUL.

The work performed under this appropriation consists chiefly in the permanent improvement of through navigation, but improvements at harbors and other localities are frequently made under allotments as provided in the various acts of Congress.

The original condition of the channel between the Missouri River and St. Paul was such that at low stages the larger boats were unable to proceed farther up the river than La Crosse or Winona, while at extreme low water navigation was impeded at points much lower. The project for its improvement was adopted in 1878, and contemplates the closure of chutes, revetment of caving banks, and contraction of the channel by wing dams, so as to obtain a channel of a depth of 4½ feet at low water, to be eventually increased to 6 feet.

At the close of the last fiscal year there had been expended on improvements $7,273,035.78, which has resulted in such an improved condition of the channel as to permit the passage of the largest boats at very low stages through to St. Paul.

At the beginning of this fiscal year there was available for the work $938,974.07. During the past year, for the permanent improvement of through navigation, work of dam construction, shore protection, dredging, removal of rock, etc., has been carried on by hired labor and use of Government plant between St. Paul and Lake Pepin, between Queens Bluff and Prairie du Chien, at Rock Island Rapids, between Keithsburg and Nashville, between Keokuk and Quincy, between Quincy and Hamburg, and between the Illinois and Missouri rivers; under formal contract, between Reeds Landing and Trempealeau, Minneiska and Queens Bluff, Dubuque and Le Claire, Rock Island and Keithsburg, Keithsburg and Nashville, Keokuk and Quincy, and between Hamburg and the Illinois River.

Under the various allotments made by act of Congress, operations have been undertaken at harbor at Burlington, Iowa; dredging Quincy Bay, Illinois; Warsaw to Quincy levee, Illinois; Flint Creek to Iowa River levee, Iowa; harbor of refuge at Kings Coulee, Lake Pepin, Minnesota; harbor at Dubuque, Iowa; harbor at Muscatine, Iowa; steamboat landing at Quincy, Ill., and Sny Island levee, Illinois.

Between St. Paul and Lake Pepin.—Necessary repairs were made to the shore protection and wing dams previously constructed between St. Paul and Prescott; a wing dam was constructed between wing dams 15 and 16, opposite Kaposia Light, and two wing dams near Island 15. Above Smiths Bar 6,125 linear feet of shore protection was constructed on the right bank and 2,420 feet on the left bank, and 6 wing dams were built. Above Island 20, 6 dams were built and the right bank above the dams was protected for a distance of 2,420 feet. The work was done by hired labor and with Government plant.

Reeds Landing to Trempealeau.—Work on this section was done under a contract with Fetter & Crosby, of La Crosse, Wis., dated December 24, 1896. Above Crats Island (below Wabasha) 4 wing dams were constructed from the left bank to straighten the channel at this locality. Above Tee-pee-ota Point, on the left bank, a lateral dam of a length of 3,170 feet was built, and opposite the point a wing dam was located. Below Grand Encampment Island the river was contracted by 3 wing dams extending from the right bank. Opposite Alma 6

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wing dams were constructed to maintain the channel along the front of the town, and the chute of Island 43 was closed. Two wing dams were also built from the left bank at Rollingstone Bar, above Fountain City, and the old dams were raised and extended.

Minneiska to Queens Bluff.—The work on this section is being done under contract with Fetter & Crosby, dated September 28, 1897. Five wing dams were constructed at Rollingstone Bar, completing the system begun under the preceding contract. The old wing dam at the head of Rollingstone was repaired, and 770 feet of shore protection was built opposite Island 55. The contract was still in force at the close of the fiscal year.

Queens Bluff to Prairie du Chien.—In the vicinity of Winona closing dams across Blacksmith Slough and below Islands 71 and 72 were raised and repaired; 4,400 feet of Richmond Island were revetted to an elevation of +3.0 feet; 3 wing dams were constructed on the opposite shore; 3 old dams were raised and extended, and 2 wing dams built above, 1 extending from Island 87 and the other from the right bank. The old closing dam behind 93 was raised and the head of the island revetted for a distance of 700 feet. Below La Crosse repairs were made to closing dams and Island 110 was revetted. Below the mouth of Root River the shore protection was extended a distance of 9,800 feet and the wing dams opposite were raised and extended. In Coon Slough 4,650 feet of the right bank was revetted. Opposite Britts Landing 2,865 feet of the shore were protected and closing dams raised and repaired. At De Soto the work of closing the slough at Main street and revetting the left bank of the river was in progress at the close of the fiscal year.

Operations in this section have been carried on by hired labor and with Government plant.

Dubuque to Le Claire.—At the close of the last fiscal year this section of the river was being improved under a contract with Albert Kirchner, dated December 14, 1896, for construction of wing dams and shore protections from Dubuque to Clinton. The contract was completed by the construction of 2,340 feet of shore protection on the left bank of the river above Fulton. Work was resumed under a contract with George W. Farley & Co., dated September 18, 1897. The upper end of Nine Mile Island was revetted for a distance of 2,825 feet, and a chute opposite the island was closed. One thousand six hundred and eighty linear feet of shore protection was constructed at the head of Island 233 and 900 linear feet on Island 241. At the close of the fiscal year the contractors were engaged in closing the chute behind Island 283.

Rock Island Rapids.—Repairs were made to existing dams where required. Below Duck Creek Chain, Dam 18 was extended to the Illinois shore and a submerged dam built below it. In widening the channel through the chains two steam-drill boats have been employed blasting rock and dredge *Ajax* in removing it. Nine thousand five hundred and three cubic yards of solid rock were blasted, 12,093 cubic yards of rock excavated, and 22,187 cubic yards of bowlders, loose rock, and clay dredged.

Rock Island to Keithsburg.—At the close of the last fiscal year work was under way in this portion of the river under a contract entered into with Patterson Brothers, approved January 2, 1897, for the construction of brush and rock dams and shore protections between Rock Island and Muscatine. Below Rock River 3 wing dams were built from the Illinois shore and 1 from the Iowa side. In the vicinity of Montpelier 6 wing dams were constructed from the island shore opposite, with the view

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of cutting off a side channel and contracting the waterway. Near Fairport, Wyoming Chute and the small chute below islands 329 and 332 were closed, a landing pier was built at Andalusia, 430 linear feet of shore was revetted near Muscatine, and minor repairs were made to other portions of the work. Operations under this contract were completed September 20, 1897.

Work was resumed under a contract with the same parties, approved October 11, 1897, for the construction of brush and rock dams and shore protections between Rock Island and Keithsburg. A wing dam was built from the Iowa shore below Fairport, 2 closing dams were constructed across small chutes near foot of Hershey Slough, and shore protection was built at Illinois City Landing, above Port Louisa, and on the right bank of Hershey Chute.

Keithsburg to Nashville.—On this section of the river work was performed both by contract and by hired labor with use of Government plant.

By hired labor: A small chute opposite Oquawka was closed and the head of the towhead protected. Six thousand six hundred and thirty feet of bank was revetted below Oquawka, 3,320 feet at the mouth of Henderson River, 1,325 feet on towhead opposite, 3,042 feet on Island 373, and 1,130 feet on the towhead at the foot of Island 375. Between the mouth of Henderson River and the foot of Island 373, 3 wing dams were constructed, and the chute between Island 375 and the towhead below was closed. Below Dallas 2 wing dams were built and the dams opposite Pontoosuc raised and strengthened. Dam C, above the Fort Madison bridge, was extended, and the revetment of Dutchmans Island completed.

By contract: Under a contract approved January 2, 1897, with Albert Kirchner, 8,004 feet of bank was protected at Crutchfield Prairie, on the Iowa side of the river, above Oquawka. Below this revetment three wing dams were built. To concentrate the river into one channel, a closing dam was constructed in Dasher Slough, opposite Oquawka, and 1,270 feet of bank revetted on Illinois shore opposite Island 360.

Keokuk to Quincy.—By hired-labor work, 1,730 feet of Island 407 was revetted, and repairs were made to 5,866 feet of shore protection. Under a contract with Albert Kirchner, approved January 2, 1897, a closing dam was built in the chute behind Buzzards Island, and the shore protection on that island extended 1,800 feet. The Illinois shore above was revetted for a distance of 1,340 feet, and that below Gregory repaired. The shore protection on Island 419 was repaired and that on La Grange Island extended 445 feet. In the vicinity of Cottonwood Island four wing dams were built from the Illinois shore and two from the Missouri shore above the island; the closing dam behind the island and wing dam at its head were repaired, and the shore protection on Illinois bank opposite was raised to the top of the bank, as also 700 feet on Missouri shore, above the Quincy Bridge. Below La Grange the shore was revetted a distance of 1,900 feet, and the revetment opposite Hogback Island carried to the top of bank and extended 1,100 feet.

Quincy to Hamburg.—One wing dam was constructed opposite Quincy, and four 6 miles below. From the Illinois shore opposite Cave Hollow two wing dams were completed and a third begun. Banks were revetted at the following points: Ortons Island, 1,450 linear feet; Fabius Island, 2,919 feet; Head of Hickory Chute, Missouri shore, 1,775 feet; Island 462, 3,400 feet; Island 468, 3,000 feet. This work was done by hired labor and Government plant.

Hamburg to Illinois River.—This portion of the river was improved

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under a contract with Albert Kirchner, approved January 2, 1897, and under contract with James Short, approved September 27, 1897. Under the first contract, a trailing dam was constructed above Turners Island and connected with the Illinois shore; the chutes on the opposite side of the river were closed by three dams. Banks were revetted at Sterling Landing, at the head of Sterling Island, and 2,325 feet on the Missouri shore, opposite Turners Island. Under the contract with James Short, the revetment opposite Turners Island was extended 1,000 feet, a trailing dam constructed at the foot of Turners Island, a closing dam constructed in the chute behind Sandy Island, and five submerged dams built—two from upper end of Iowa Island and three from the Illinois shore above Brocks Landing.

Illinois River to Missouri River.—This work was done by hired labor and use of Government plant. Trailing dams were constructed at Riverside Park, Hop Hollow, opposite Search Island, and between Portage Island and Eagle Nest Island. In the chute behind Eagle Nest Island a closing dam was constructed to increase the flow in the main channel.

The following is a brief synopsis of the operations under and of the conditions of the various special allotments made by act of Congress:

Constructing a harbor of refuge on the west shore of Lake Pepin, Mississippi River, at or near Kings Coulee, between Lake City and Reeds Landing, Minnesota.—Thirty thousand dollars was allotted for this purpose by act of Congress of June 3, 1896. At the close of the last fiscal year about 400 linear feet of the pier forming the harbor had been constructed. During the past season the pier has been extended 150 feet, and work is now in progress on 50 feet additional. The pier is constructed of a foundation course of gravel protected with riprap, and a substructure of brush and stone extending to a height of 12 feet above low water of 1864, with a width of crown of 10 feet, and slopes of about 1 on 1.

Harbor at La Crosse, Wisconsin.—The river and harbor act of June 3, 1896, allotted $5,000 for maintaining this harbor. As the results of a survey ordered by the same act were such as to show that about $17,000 was needed to perform proper work, the sum allotted was reserved until further funds became available.

Removal of bars at Dubuque, Iowa.—In the act making appropriation for sundry civil expenses, approved June 4, 1897, $30,000 was allotted for "removing the sand bar which obstructs the channel of the Mississippi River in front of Dubuque, Iowa, and the entrance to the harbor of refuge at Dubuque, Iowa." For the purpose of removing these obstructions a contract was entered into with Charles H. Appleton, approved September 16, 1897. The contract was completed June 25, 1898, 114,937 cubic yards of material having been removed.

Harbor at Rock Island, Ill.—The river and harbor act of June 3, 1896, allotted $5,000 for maintaining the harbor at Rock Island, Ill. Work on this project was in progress at the close of the last fiscal year, when 300 feet of the steamboat landing had been improved by the removal of 2,243 cubic yards of rock. The work was completed as far as funds available would permit by the removal of rock a farther distance of 100 feet. The excavation was carried to a depth of 4 feet below low water of 1864. The total amount of material removed was 3,850 cubic yards.

Harbor at Muscatine, Iowa.—The act approved June 4, 1897, making appropriation for sundry civil expenses, allotted $15,000 for "removing the sand bar which obstructs the channel in front of Muscatine, Iowa." A contract was entered into with A. J. Whitney, approved September

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8, 1897, for the removal of this obstruction. The bar was dredged to a depth of 6 feet at low water, and the work completed June 28, 1898, 89,590 cubic yards of material having been removed.

Harbor at Burlington, Iowa.—Of an allotment of $5,000 for dredging the harbor at Burlington, contained in the river and harbor act of September 19, 1890, there remained a balance of $3,094.38 at the close of the last fiscal year. As there has been some deposit since the harbor front was dredged in 1890, this balance was expended in redredging the harbor, the Government dredge *Phœnix* being employed for the purpose. The amount of material removed was 8,799 cubic yards.

Dredging Quincy Bay, Illinois.—The river and harbor act of June 3, 1896, provided $15,000 for dredging the channel in Quincy Bay. Under this allotment work was begun with Government plant on June 2, 1898. At the close of the fiscal year 37,209 cubic yards of material had been excavated, the depth of cut being 6 feet below low water.

Steamboat landing at Quincy, Ill.—In the river and harbor act of June 3, 1896, there was allotted $10,000 for "removing the sand bar in front of the steamboat landing at Quincy, in the State of Illinois." During the fiscal year ending June 30, 1897, 42,000 cubic yards of material were dredged and removed from the bar, but the cuts were filled during the next high water. The wing dam on the opposite side of the river has been extended 363 feet, with more success, having caused the river currents to cut away about 800 feet of the lower part of the bar. The balance available, $4,902.57, is being held until the final results from this contraction of the river can be obtained.

Sny Island Levee.—The river and harbor act of June 3, 1896, allotted $50,000 for "the protection from erosion of the east bank of the Mississippi River along and in front of the Sny Island Levee, in the counties of Adams, Pike, and Calhoun, in the State of Illinois, and for the improvement and maintenance of the channel of the river by revetment works or otherwise." This allotment has been applied to the construction of shore protection and dams at such localities as would not only improve the low-water channel of the river, but also afford protection to the Sny Levee from caving banks. Six thousand eight hundred and seventy-five feet of bank at Cincinnati Landing was revetted, the chute closed behind Cottel Island, and a wing dam constructed above to divert the current from the levee at this place. A closing dam was also built above North Fritz Island for the purpose of diverting the water and preventing caving in the slough behind the island, and concentrating the water in the navigable channel of Hickory Slough.

Warsaw and Quincy Levee.—The river and harbor act of June 3, 1896, provided $5,000 for the "repair and maintenance of the natural and artificial banks from Warsaw to Quincy." The funds allotted were expended in closing a crevasse in the levee at Station 295, which occurred during the flood of 1897.

Flint Creek to Iowa River Levee.—In the act making appropriations for sundry civil expenses, approved June 2, 1895, it is provided that "$85,000 shall be expended to commence the work, under the direction of the Secretary of War, from the mouth of Flint Creek, in Des Moines County, State of Iowa, and running along the west bank of the river, with a view to improving the navigation by preventing the water from overflowing the natural and artificial banks along that part of the river and by deepening the channel." The river and harbor act of June 3, 1896, allotted $75,000 for continuing the improvement, and the sundry civil act of June 4, 1897, made a further allotment of $50,000 for the same purpose, making a total of $210,000. At the close of the last

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fiscal year 22 miles of levee had been constructed, containing 764,188 cubic yards, and 3,304 feet of the bank of the Iowa River protected from caving. During the present fiscal year there have been put in place 350,016 cubic yards of earth, extending the levee line about 4 miles. The estimate of cost of this levee from the preliminary survey was $305,000. In the last annual report this estimate is reduced to $250,000. I am of the opinion that this reduction is not advisable, the section adopted being a weak one, particularly if there should be any increase in flood heights due to levee construction.

The details of the above-mentioned improvements are given in the appended reports of assistants in local charge.

Commercial statistics accompany my report on operating snag boats and dredge boats on the Upper Mississippi River.

General remarks.—The improvement of the Upper Mississippi River has been carried on gradually, giving the river itself opportunity to assist in the formation of proper channels. The project adopted for its improvement during the past twenty years contemplates utilizing only the low-water discharge for that purpose, closing dams, wing dams, and training walls having been constructed to heights rarely exceeding 5 feet, the water at high stages being unrestrained. The estimated cost of the improvement by this project is about $20,000 per mile.

Recent acts of Congress have directed the improvement of the navigation of certain portions of the river by preventing the water from overflowing the natural and artificial banks, thus contemplating the utilization of the forces exerted at high water for deepening the channel. The two methods of improvement are incompatible. The one acting on the low-water currents seeks to disturb the existing regimen of the river as little as possible, and opens a navigable channel through bars on lines of the least excavation. If the forces exerted during floods are to be utilized for improving the low-water navigation, the low-water channel must be so located that currents during high water will tend to scour it out, for whenever the low-water channel and the high-water currents differ in direction the low-water channel will be filled with sand. The channel, as improved for the past twenty years, consists of pools on alternate sides of the river, extending generally in the direction of high-water currents, connected by crossings on bars, which are inclined to these currents. The results of intensifying the action of floods will be to increase the scour in the pools where the river is already sufficiently deep for navigation, and tend to obliterate the channel in the bars.

It will be impracticable to adjust the low-water channel to high-water currents without extensive modifications of the work already done, and at great expense, as the entire regimen of the river will have to be changed and sand bars of great magnitude removed.

The construction of levees on the banks of the Upper Mississippi is worthy of careful consideration for the benefits which will accrue to the agricultural interests of the valley, if for no other reason; but if the work is to be undertaken it should be in accordance with a carefully matured plan. The method of building detached portions of levee, considering only local conditions at the time the levee is located, and without taking into account the influence of further development of the system, can lead only to disaster. Future levee construction will raise flood heights to such an extent as to overwhelm the earlier structures and cause ruin to those who have developed land under the protection at first afforded. Where the levee line extends through several States,

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a national control of the entire system seems essential; but if the General Government is to assume such responsibility, a matured plan for leveeing the entire valley should be evolved, arrangements made for the repair and protection of the levee line when built, and laws enacted defining the duties and responsibilities of the property holders in the districts leveed. The special allotments by Congress for levee construction contain one vital defect. Being appropriations for specific objects, only the amount appropriated can be expended, and upon completion of the levee there is no provision for maintenance and high-water protection. The results of the first high flood in those districts which have no local levee organization can readily be predicted.

Summary of expenditures for calendar year ending December 31, 1897, for improving Mississippi River from Missouri River to Minneapolis.

Minneapolis to St. Paul	$2,807.57
St. Paul to Lake Pepin	33,131.51
Reeds Landing to Trempealeau	31,737.87
Kings Coulee Pier, Lake Pepin	16,202.15
Queens Bluff to Prairie du Chien	66,187.85
Harbor at Dubuque	11,094.53
Dubuque to Le Claire	41,254.21
Rock Island Rapids	47,812.48
Rock Island Harbor	1,313.34
Rock Island to Keithsburg	47,090.72
Muscatine Harbor	4,297.58
Flint Creek to Iowa River Levee	47,013.54
Keithsburg to Nashville	68,705.00
Burlington Harbor	638.78
Keokuk to Quincy	6,084.20
Warsaw to Quincy Levee	9,185.93
Quincy Harbor	259.71
Quincy to Hamburg	35,894.84
Sny Island Levee	26,770.81
Hamburg to Illinois River	33,771.02
Illinois River to Missouri River	72,841.81
Surveys and gauges	6,516.06
Purchase, care, and repair of plant	24,752.06
Total	635,363.57

NOTE.—In above statement retained percentages and delayed estimates on contracts, December 31, 1897, are included.

Summary showing localities, amounts, and cost of regular construction works in 1897 between St. Paul and mouth of Missouri River.

Locality.	Method.	Material.		
		Rock.	Brush.	Total.
		Cubic yds.	*Cubic yds.*	*Cubic yds.*
St. Paul to Lake Pepin	Hired labor	31,071.8	27,539.7	58,611.5
Queens Bluff to Prairie du Chien	do	51,274.9	134,077.6	185,352.5
Keithsburg to Nashville	do	26,051.8	32,737.2	58,789
Keokuk to Quincy	do	6,306.6	1,646.5	7,953.1
Quincy to Hamburg	do	21,970.4	51,780.5	73,750.9
Protecting Sny Island Levee	do	18,851.4	40,986	59,837.4
Illinois River to Missouri River	do	49,164.2	112,740	161,904.2
Reeds Landing to Trempealeau	Formal contract	18,223.9	66,944.6	85,168.5
Dubuque to Clinton	do	29,673	32,574.4	62,247.4
Dubuque to Le Claire	do	5,104.1	8,820	13,924.7
Rock Island to Muscatine	do	26,122	26,622.2	52,744.2
Rock Island to Keithsburg	do	13,131.5	10,963.6	24,095.1
Keithsburg to Nashville	do	28,042.6	28,942.8	56,985.4
Hamburg to Illinois River	do	23,219.1	33,208.2	56,427.3
Total		343,207.3	609,583.9	957,791.2

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Summary showing localities, amounts, and cost of regular construction works in 1897 between St. Paul and mouth of Missouri River—Continued.

Locality.	Cost of work.	Average cost per cubic yard on barges.	Average cost per cubic yard for towing and putting in material.	Average cost per cubic yard for general superintendence, office expenses, and inspection.	Average cost per cubic yard for plant.	Average cost per cubic yard in place.
St. Paul to Lake Pepin	$32,854.51	$0.231	$0.268	$0.016	$0.045	$0.560
Queens Bluff to Prairie du Chien	74,253.28	.209	.137	.011	.044	.401
Keithsburg to Nashville	35,123.40	.366	.165	.017	.049	.597
Keokuk to Quincy	6,706.02	.432	.310	.023	.078	.843
Quincy to Hamburg	39,132.44	.266	.206	.014	.044	.530
Protecting Sny Island Levee	28,380.35	.272	.174	.....	.027	.473
Illinois River to Missouri River	78,977.78	.285	.151	.014	.038	.488
Reeds Landing to Trempealeau	31,837.71	.....	.....	.031	.....	.374
Dubuque to Clinton	34,257.37	.....	.....	.032	.....	.550
Dubuque to Le Claire	7,054.19	.....	.....	.050	.....	.507
Rock Island to Muscatine	29,903.17	.....	.....	.034	.....	.567
Rock Island to Keithsburg	13,610.73	.....	.....	.037	.....	.565
Keithsburg to Nashville	35,396.37	.....	.....	.032	.....	.621
Hamburg to Illinois River	34,818.30	.....	.....	.029	.....	.617
Total	482,305.72	.....	.....	.....	.....	.504

Average cost per cubic yard in place, hired-labor work	$0.487
Average cost per cubic yard in place, contract work	.531

The average cost per cubic yard of hired-labor work has been lowered from $0.76 in 1892 to $0.487 in 1897—a reduction of 27.3 cents, or 35.5 per cent.

The average cost per cubic yard of contract work has been lowered from $0.88 in 1892 to $0.531 in 1897—a reduction of 34.9 cents, or 39.6 per cent.

Hired-labor work—Average cost of towing and putting in material.

1891	$0.233	1895	$0.197
1892	.295	1896	.255
1893	.237	1897	.170
1894	.214		

The average cost per cubic yard by hired labor and contract combined has been reduced from $0.804 in 1893 to $0.504 in 1897—a reduction of 30 cents per cubic yard, or 37.5 per cent.

General statement showing net expenditures from the commencement of improvement to July 1, 1898, under various appropriations.

St. Paul to Des Moines Rapids	$1,560,323.17
St. Paul to Des Moines Rapids (practical test of Adams flume)	*22,176.83
St. Paul to Des Moines Rapids (harbor at Lake City)	15,000.00
Minneapolis to Des Moines Rapids	1,100,000.00
Des Moines Rapids to Illinois River	1,330,000.00
Ohio River to Minneapolis (applied to "between mouth of Missouri River and Minneapolis")	4,098,007.22
Expenditures	8,125,507.22
Less amount transferred to work at Lock and Dam No. 2, Mississippi River, between Minneapolis and St. Paul, act of August 18, 1894	49,877.67
Total net expenditures	8,075,629.55
Balance July 1, 1898: Ohio River to Minneapolis	328,659.46
Total	8,404,289.01

*In addition to this amount Mr. Adams expended $13,000, appropriated by acts of August 2, 1882, and July 13, 1892.

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Net expenditures on the various sections of the river between Minneapolis and the Missouri River from commencement of improvement to July 1, 1898 (Rock Island and Des Moines Rapids improvement not included).

Locality.	Distance.	Amount.	Per mile.
	Miles.		
St. Paul to Minneapolis	11	$59,113.46	
St. Paul to Prescott	32	677,169.25	$21,161.54
Prescott to Lake Pepin	29	280,840.40	9,684.14
Harbors in Lake Pepin		45,468.92	
Foot of Lake Pepin to Alma	12	379,307.08	31,608.92
Alma to Winona Bridge	29	488,430.71	16,842.44
Winona Bridge to La Crosse Bridge	31	303,887.71	9,802.83
La Crosse Bridge to McGregor Bridge	72	578,570.72	8,035.70
McGregor Bridge to Dubuque Bridge	59	178,289.11	3,021.85
Dubuque Bridge to Clinton Bridge	67	290,934.91	4,342.31
Clinton Bridge to Rock Island Bridge	40	455,968.86	11,399.22
Rock Island Bridge to Keithsburg Bridge	58	211,884.37	3,653.18
Keithsburg Bridge to Des Moines Rapids	60	704,319.06	11,738.65
Keokuk Bridge to Quincy Bridge	40	487,003.71	12,175.09
Quincy Bridge to Clarksville	60	793,886.04	13,231.43
Clarksville to Cap au Gris	43	587,446.91	13,661.56
Cap au Gris to Illinois River	27	278,868.08	10,328.45
Illinois River to Missouri River	25	352,518.03	14,100.72
Flint Creek to Iowa River Levee		150,702.23	
Warsaw to Quincy Levee		89,269.95	
Soy Levee		94,242.50	
Quincy Bay		a61,963.25	
Hamburg Bay		10,000.00	
Quincy Harbor		5,097.43	
Rock Island Harbor		5,000.00	
Dubuque harbors		34,860.10	
Muscatine Harbor		15,000.00	
Surveys, gauges, and meter work		197,904.17	
Snag and dredge boats and wrecking		59,661.11	
Facilitating navigation through bridges		2,072.72	
Practical test of Adams flume		27,176.83	
Plant at estimated value		168,771.93	
Total		8,075,629.55	

a $25,000 additional expended at Quincy Bay under special appropriation.

Money statements.

MINNEAPOLIS TO DES MOINES RAPIDS.

July 1, 1897, balance unexpended and available belonging to harbor at Burlington, Iowa	$3,094.38
June 30, 1898, amount expended during fiscal year	3,094.38

OHIO RIVER TO MINNEAPOLIS, APPLIED TO THAT PORTION OF THE RIVER BETWEEN THE MOUTH OF THE MISSOURI RIVER AND MINNEAPOLIS.

July 1, 1897, balance unexpended		*$944,280.48
Amount appropriated by act approved July 19, 1897		200,000.00
Amount appropriated by sundry civil act approved July 1, 1898		826,666.67
		1,970,947.15
June 30, 1898, amount expended during fiscal year		815,621.02
July 1, 1898, balance unexpended		1,155,326.13
July 1, 1898, outstanding liabilities	$16,338.03	
July 1, 1898, amount covered by uncompleted contracts	159,050.57	
		175,388.60
July 1, 1898, balance available		979,937.53
Amount that can be profitably expended in fiscal year ending June 30, 1900		1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

*The balance unexpended July 1, 1897, is $33,756.04 less than given last year, said amount having been transferred to appropriation for Lock and Dam No. 2.

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ABSTRACT OF APPROPRIATIONS.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000.00
March 3, 1879	100,000.00
June 14, 1880	150,000.00
March 3, 1881	200,000.00
By act passed August 2, 1882	250,000.00
By act approved—	
July 5, 1884 (general improvement)	250,000.00
July 5, 1884 (applied to harbor, Lake City)	15,000.00
August 5, 1886	382,500.00
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000 00
By act of September 19, 1890	500,000.00
Des Moines Rapids to Illinois River:	
By act approved—	
June 18, 1878	100,000.00
March 3, 1879	40,000.00
June 14, 1880	100,000.00
March 3, 1881	175,000.00
By act passed August 2, 1882	200,000.00
By act approved:	
July 5, 1884	200,000.00
August 5, 1886	150,000.00
By act of August 11, 1888	200,000.00
By act of September 19, 1890	165,000.00
Ohio River to Minneapolis, applied to "between Missouri River and Minneapolis:"	
By act approved—	
July 13, 1892	600,000.00
March 3, 1893 (sundry civil)	866,666.67
August 18, 1894 (sundry civil)	866,666.67
March 2, 1895 (sundry civil)	866,666.67
By act of June 3, 1896	200,000.00
By act of June 4, 1897 (sundry civil)	826,666.67
By act of July 19, 1897 (deficiency)	200,000.00
By act of July 1, 1898 (sundry civil)	826,666.67
Total	9,280,833.35
Less amount transferred to work at Lock and Dam No. 2, Mississippi River, between Minneapolis and St. Paul, act August 18, 1894	49,877.67
	9,230,955.68

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "construction of dams and shore protections between Minneiska and Queens Bluff, Minn."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn. * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $35,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	20,000 cubic yards rock in place.		60,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$20,000	$0.19	$11,400	$31,400
2	Fetter & Crosby, La Crosse, Wis	.98	19,600	.19	11,400	a 31,000
3	Jacob Richtman, Fountain City, Wis	1.00	20,000	.30	18,000	38,000

a Recommended for acceptance; accepted and written contract made.

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Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of dams and shore protections between Prairie du Chien, Wis., and Dubuque, Iowa."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $35,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	20,000 cubic yards rock in place.		40,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	A. B. Teasdale, Caseville, Wis	$1.00	$20,000	$0.30	$12,000	$32,000
2	George W. Farley & Co., Dubuque, Iowa	.69	13,800	.31	12,400	26,200
3	Albert Kirchner, Fountain City, Wis	.90	18,000	.19	7,600	a 25,600
4	A. J. Whitney, Rock Island, Ill	1.00	20,000	.30	12,000	32,000
5	Fetter & Crosby, La Crosse, Wis	1.00	20,000	.25	10,000	30,000
6	Jacob Richtman, Fountain City, Wis	1.00	20,000	.30	12,000	32,000

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of dams and shore protections between Dubuque and Leclaire, Iowa."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $35,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	20,000 cubic yards rock in place.		40,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	A. B. Teasdale, Caseville, Wis	$1.00	$20,000	$0.34	$13,600	$33,600
2	George W. Farley & Co., Dubuque, Iowa	.69	13,800	.32	12,800	a 26,600
3	Albert Kirchner, Fountain City, Wis	1.00	20,000	.19	7,600	27,600
4	A. J. Whitney, Rock Island, Ill	1.00	20,000	.22	8,800	28,800
5	Patterson Bros., Keokuk, Iowa	1.00	20,000	.40	16,000	36,000
6	James Short, St. Charles, Mo	.90	18,000	.40	16,000	34,000
7	Fetter & Crosby, La Crosse, Wis	1.00	20,000	.28	11,200	31,200
8	Jacob Richtman, Fountain City, Wis	1.10	22,000	.30	12,000	34,000

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of dams and shore protections between Rock Island and Keithsburg, Ill."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $50,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	40,000 cubic yards rock in place.		35,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$40,000	$0.19	$6,650	$46,650
2	A. J. Whitney, Rock Island, Ill	1.00	40,000	.25	8,750	48,750
3	Patterson Bros., Keokuk, Iowa	.80	32,000	.20	7,000	a 39,000
4	James Short, St. Charles, Mo	.90	36,000	.32	11,200	47,200
5	Jacob Richtman, Fountain City, Wis	1.00	40,000	1.00	35,000	75,000

a Recommended for acceptance; accepted, and written contract made.

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Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of dams and shore protections between Keokuk, Iowa, and Quincy, Ill."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $35,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	20,000 cubic yards rock in place.		40,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$20,000	$0.25	$10,000	a $30,000
2	A. J. Whitney, Rock Island, Ill	1.20	24,000	.80	12,000	36,000
3	Patterson Bros., Keokuk, Iowa	.85	17,000	.40	16,000	33,000
4	James Short, St. Charles, Mo	1.00	20,000	.35	14,000	34,000
5	Jacob Richtman, Fountain City, Wis	1.10	22,000	.40	16,000	38,000

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of dams and shore protections between Hamburg, Ill., and the mouth of the Illinois River."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $50,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	35,000 cubic yards rock in place.		55,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	William P. Truax, Hastings, Minn	$0.99	$34,650	$0.49	$26,950	$61,600
2	Albert Kirchner, Fountain City, Wis	1.00	35,000	.30	16,500	51,500
3	James Short, St. Charles, Mo	.80	28,000	.40	22,000	a 50,000
4	Golike & Rust, Alton, Ill	.93	32,550	.36	19,800	52,350
5	Jacob Richtman, Fountain City, Wis	1.15	40,250	.30	16,500	56,750

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Dredging at Dubuque, Iowa."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $30,000, made by said act and by project approved July 9, 1897.]

No.	Name and residence of bidder.	Dredging and removing 180,000 cubic yards.	
		Per cubic yard.	Total.
1	Richard W. Hosford, Dubuque, Iowa	$0.2375	$42,750
2	H. S. Brown, Quincy, Ill	.1550	27,900
3	A. J. Whitney, Rock Island, Ill	.15	27,000
4	Charles H. Appleton, Quincy, Ill	.1490	a 26,820

a Recommended for acceptance; accepted, and written contract made.

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Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Dredging at Muscatine, Iowa."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn.: * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $15,000, made by said act and by project approved July 9, 1897.]

No.	Name and residence of bidder.	Dredging and removing 90,000 cubic yards.	
		Per cubic yard.	Total.
1	A. J. Whitney, Rock Island, Ill	$0.15	a $13,500
2	H. S. Brown, Quincy, Ill	.155	13,950

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., August 14, 1897, at 11 a. m., for "Construction of levees between Flint Creek and Iowa River."

[There is available for this work from appropriation of $826,666.67, made by sundry civil act approved June 4, 1897, for "Improving Mississippi River from mouth of Ohio River to St. Paul, Minn. * * * For continuing improvement from the mouth of the Missouri River to St. Paul," an allotment of $95,000, made by project approved July 9, 1897.]

No.	Name and residence of bidder.	Sections 23–27—300,000 cubic yards earthwork in place.		Sections 28–32—335,000 cubic yards earthwork in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Cameron, McManus & Joyce, Keokuk, Iowa	$0.15	$45,000.00	$0.16	$53,600.00	$98,600.00
2	Murray Bros., Dubuque, Iowa	.14	42,000.00	.145	48,575.00	90,575.00
3	John J. McCaughey, Summit, Ill	.1025	30,750.00	.115	38,525.00	69,275.00
4	McDonnell & Kennedy, Fargo, N. Dak.	.889	26,670.00	.1074	35,979.00	a 62,649.00
5	Callahan Construction Co., Omaha, Nebr	.1275	38,250.00	.13	43,550.00	81,800.00
6	John A. O'Keefe & Co., Omaha, Nebr	.1175	35,250.00	.135	45,225.00	80,475.00
7	J. W. Thompson, St. Louis, Mo	.1139	34,170.00	.1139	38,156.50	72,326.50

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Charles Keller, Corps of Engineers, at Rock Island, Ill., September 7, 1897, at 11 a. m., for "Dredging in Galena River, Illinois."

[There is available for this work, under section 4 of river and harbor act of July 5, 1884, for "Operating and care of canals and other works of navigation," an allotment of $8,000 made available for dredging in Galena River by project and estimate for care and maintenance of Galena River improvement for fiscal year ending June 30, 1898, approved by Secretary of War July 15, 1897, as per Department letter of July 20, 1897, inclosure 5 of 6907.]

No.	Name and residence of bidder.	Dredging and removing 30,000 cubic yards material and towing 4½ miles or less.	
		Per cubic yard.	Total.
1	Grant-Galena Company, Dubuque, Iowa	$0.24½	$7,425
2	H. S. Brown, Quincy, Ill	.26	7,800

NOTE.—Both bids rejected, price being considered too high.

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List of contracts in force July 1, 1898, for improvement work on Mississippi River between mouth of Missouri River and St. Paul.

Name and residence of contractor.	Designation and location of work.	Date of approval.	Commencement of work.	Expiration of contract.
Fetter & Crosby, La Crosse, Wis.	Building dams and shore protection: Minneiska to Queens Bluff.	Oct. 11, 1897	June 13, 1898	Sept. 30, 1898
Albert Kirchner, Fountain City, Wis.	Building dams and shore protection: Prairie du Chien to Dubuque.	.....do	Not begun.	Do.
Geo. W. Farley & Co., Dubuque, Iowa.	Building dams and shore protection: Dubuque to Leclaire.	.....do	Sept. 27, 1897	Do.
Patterson Bros., Keokuk, Iowa.	Building dams and shore protection: Rock Island to Keithsburg.	.....do	Sept. 20, 1897	Do.
James Short, St. Charles, Mo.	Building dams and shore protection: Hamburg to mouth of Illinois River.	Sept. 27, 1897	Mar. 30, 1898	Do.
McDonnell & Kennedy, Fargo, N. Dak.	Building levees: Flint Creek to Iowa River.	Nov. 5, 1897	Nov. 23, 1897	Do.

Comparative cost of materials, 1897.

Locality of delivery.	Rock, per cubic yard.		Brush, per cubic yard.		Earthwork, per cubic yard.
	In place.	On United States barges.	In place.	On United States barges.	In place.
St. Paul to Hastings	.....	.....	.....	$0.148	.....
Pine Bend to Lake Pepin	.....	.....	.....	.1575	.....
Pine Bend to Redwing	.....	.....	.....	.15	.....
Nininger	.....	$0.245	.....	.....	.....
Do	.....	.28	.....	.....	.....
Do	.....	.30	.....	.....	.....
Do	.....	.32	.....	.....	.....
Prescott, vicinity of	.....	.295	.....	.....	.....
Vermillion Slough	.....	.....	.....	.15	.....
Lake St. Croix, vicinity of	.....	.30	.....	.....	.....
Point Douglas	.....	.37	.....	.....	.....
Dudley Island, vicinity of	.....	.....	.....	.14	.....
Kings Coulee, within 1 mile of	.....	.44	.....	.....	.....
Kings Coulee, within 6 miles of	.....	.40	.....	.....	.....
Kings Coulee, within 15 miles of	.....	.....	.....	.124	.....
Reeds Landing to Trempealeau	$0.97	.....	$0.17	.....	.....
Winona to Lansing	.....	.....	.....	.1225	.....
Minneowa to Dresbach	.....	.445	.....	.....	.....
Do	.....	[a].315	.....	.....	.....
Dubuque to Clinton	.90	.....	.17	.....	.....
Dubuque to Leclaire	.69	.....	.32	.....	.....
Clinton to Cordova	.....	.....	.....	.18	.....
Cordova, vicinity of	.....	.48	.....	.....	.....
Rock Island to Muscatine	.84	.....	.23	.....	.....
Rock Island to Keithsburg	.80	.....	.20	.....	.....
Iowa River	.....	[b]1.37	.....	.....	.....
Do	.....	[b]1.495	.....	.....	.....
Do	.....	.....	.....	[b].17	.....
Do	.....	.....	.....	[b].20	.....
Flint Creek to Iowa River	.....	.....	.....	.....	$0.1039
Do	.....	.....	.....	.....	.0689
Do	.....	.....	.....	.....	.1074
Do	.....	.....	.....	.....	.1175
Do	.....	.....	.....	.....	.1090
Do	[c]6.15	.....	.....	.....	.....
Do	1.98	.....	.....	.....	.....
Do	[c]4.15	.....	.....	.....	.....
Do	2.00	.....	.....	.....	.....
Mouth of Iowa Slough	.....	[b]1.30	.....	[b].25	.....
Keithsburg to Nashville	1.00	.....	.19	.....	.....
Burlington, vicinity of	.....	.635	.....	.....	.....
Do	.....	.63	.....	.....	.....
Burlington to Fort Madison	.....	.....	.....	.18	.....
Dallas City, vicinity of	.....	.55	.....	.....	.....
Pontoosuc	.....	.50	.....	.....	.....
Lead Island, vicinity of	.....	.....	.....	.1775	.....

[a] Sand rock. [b] On bank. [c] Rubblestone.

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Comparative cost of materials, 1897—Continued.

Locality of delivery.	Rock, per cubic yard.		Brush, per cubic yard.		Earth-work, per cubic yard.
	In place.	On United States barges.	In place.	On United States barges.	In place.
Appanoose		$0.595			
Ballingers, vicinity of		.55			
Keokuk		.525			
Warsaw to Quincy Levee, Hunt and Lima Lake district					$0.1975
Canton to Lagrange		.49			
Quincy, vicinity of				$0.16	
Quincy to Hannibal				.17	
Do				.18	
Do				.19	
Quincy and Hannibal		.52			
Hannibal, vicinity of		.47			
Quincy to Hamburg				.18	
Do				.19	
Saverton to Mosiers Landing				.15	
Saverton and Cincinnati Landing		.52			
Louisiana		.465			
Do		.44			
Louisiana to Mosiers Landing				.18	
Opposite Clarksville				.19	
Grafton				.15	
Grafton to mouth of Missouri River				.22	
Grafton to Alton		.45			
Mouth of Illinois to mouth of Missouri River				.21	
Hop Hollow		.45			

NOTE.—Dredging and removing sand and mud at Dubuque, per cubic yard, 14⅞ cents; at Galena River, per cubic yard, 19⅜ cents; at Muscatine, per cubic yard, 15 cents. The price per cubic yard of hard rock delivered on barges varied from 24½ cents at Nininger to 63½ cents at Burlington. The average cost of this rock during the season was 45½ cents. The price of brush delivered on barges varied from 12½ cents between Winona and Lansing to 22 cents between Alton and the Missouri River. The average cost of brush during the season was 16½ cents.

REPORT OF MR. J. D. DUSHANE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 4, 1898.

COLONEL: I have the honor to submit the following report of operations under my direction for improving the Mississippi River between Minneapolis and Lake Pepin for the calendar year 1897:

MINNEAPOLIS TO ST. PAUL.

Lock and Dam No. 2.—In accordance with instructions from the Chief of Engineers, United States Army, dated October 8, 1897, directing you to transfer to Capt. F. V. Abbot the charge of the improvement of the Mississippi River between the Chicago, St. Paul, Minneapolis and Omaha Railway Bridge at St. Paul and the Washington Avenue Bridge at Minneapolis, this work was turned over to Captain Abbot on October 18, 1897. Previous to this time the plans of the lock had been well advanced, and negotiations for lock site and flowage rights, after many annoying delays, had been practically completed; deeds had been secured for all the land required and for all flowage rights excepting one 50-foot lot. A number of these deeds at the time of the transfer were in course of examination by the Department of Justice.

ST. PAUL TO LAKE PEPIN.

The improvement of the river between St. Paul and Lake Pepin was continued under project approved July 9, 1897, by hired labor and use of Government plant.

Building dams and shore protections.—Work for the season was resumed August 3, 1897, and comprised repairs to works of improvement between St. Paul and Prescott and construction of new works of improvement, as designated in the list of works showing the extent of repairs made and the dimensions of works constructed. A moderately high stage of water prevailing at the beginning of operations very greatly facilitated the delivery of materials for repair work.

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Shore protections at Frenchmans Light, at Pigs Eye Light, at Quarantine Light, in the vicinity of St. Paul Park, and above and below Hastings, were raised and repaired, and at Quarantine Light and above and below Hastings the shore protections were extended. Closing Dam 25 (sheet 1),* Closing Dam 2 (sheet 3), Wing Dam 8 and Closing Dam 3 (sheet 4), and Wing Dam 2 (sheet 7) were raised and repaired.

Opposite Kaposia Light, Wing Dam 56, located midway between Dams 15 and 16 (sheet 2), and in the vicinity of Island 15, Wing Dams 57 and 58, located, respectively, midway between Dams 12 and 13 and 15 and 44 (sheet 5), were built principally of sand delivered by the hydraulic dredge *Geyser*, and it is expected they will greatly assist in permanently improving the dredged channel. In the vicinity of Smiths Bar and Island 20, the following works were constructed for the purpose of improving and maintaining the channel substantially in its present position: Above Smiths Bar the right bank was protected for a distance of 6,125 feet, and, extending from the right bank below the protection, Dams 28, 29, and 30 (sheet 8) were built of brush and rock, making the projected work for this side of the river complete from Dam 14 to Dam 1. Extending from the opposite bank Dams 31, 32, and 33 were built of brush and rock, and the left bank was protected from near Dam 33 to Dam 2, a distance of 2,420 feet. Above Island 20, 6 dams were built, 3 on either side of the channel, and the right bank above the dams was protected for a distance of 2,490 feet. Dam 37, the upper dam extending from the left bank, was built of brush and rock. Dams 34, 35, and 36, extending from the right bank, and 38 and 39, extending from the left bank, were constructed principally of sand dredged from the channel.

Materials were purchased in open market, under competition, at the following prices per cubic yard delivered on United States barges: For brush, 14 to 14¼ cents; for riprap rock, 24½ to 37 cents. U. S. towboat *Fury* and launch *Emily* were engaged in towing material to the works.

The following table, offered to show the comparative cost of brush and rock dams and of sand dams as built in this part of the river, presents estimates of materials, computed in accordance with the office tables and corrected for length of brush used, the actual amounts of materials used, and the comparative cost, based upon the following estimated prices for materials in place: Rock, 82.9 cents; brush, 22.4 cents, and sand, 6.9 cents. These prices for materials in place are in conformity with the financial statements herein given, omitting the item of general superintendence and office expenses for building dams, and for brush and rock are proportional to and lower than the average cost per cubic yard for materials in place in similar works in your district under contracts for the year 1897.

Statement of estimated and actual amounts of materials used, and comparative cost for dams built between St. Paul and Lake Pepin during the season of 1897.

Designation.	Estimated amount of material to build according to office tables.		Actual amounts of materials used.			Cost in place for estimated amount of material.	Cost in place for actual amount of material used.
	Rock.	Brush.	Rock.	Brush.	Sand.		
Rock and brush dams:							
Sheet 8—	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*		
Dam 28	650	563	313.9	874.5	.....	$664.96	$456.11
Dam 29	1,441	1,278	636.5	1,761.2	.....	1,480.86	922.16
Dam 30	1,530	1,373	750.1	1,960.6	.....	1,575.92	1,061.01
Dam 31	1,592	1,440	761.8	2,116	.....	1,642.33	1,105.51
Dam 32	1,266	1,134	686.1	1,743.3	.....	1,303.53	959.28
Dam 33	600	540	236.7	518.4	.....	618.36	312.34
Dam 37	850	708	514.5	891.6	.....	863.24	626.24
Total	7,929	7,036	3,899.6	9,865.6	.....	8,149.20	5,442.65
Rock, brush, and sand dams:							
Sheet 8—							
Dam 34	722	612	257.8	200	1,960	735.62	393.75
Dam 35	1,130	1,017	326.8	250	3,790	1,164.58	588.42
Dam 36	1,620	1,427	336.1	447.3	4,120	1,662.63	663.10
Dam 38	745	621	394.4	602.5	†800	756.71	517.11
Dam 39	639	573	89.2	150	1,650	658.08	221.40
Sheet 2—							
Dam 56	1,849	1,197	255.4	177.4	4,570	1,886.44	566.79
Sheet 5—							
Dam 57	1,204	1,086	157.1	192.7	2,730	1,241.37	361.78
Dam 58	600	513	159.3	239.2	1,560	612.32	293.28
Total	8,009	7,046	1,976.1	2,259.1	21,180	8,217.75	3,605.63

* Sheet numbers are those of general maps, servey of 1878-79.
† This dam was built out 190 feet with sand, and extended and completed with rock and brush.

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It will be noticed that the office table estimates call for about equal quantities of rock and brush, whereas in this river a lighter construction seems to fill every requirement without any appreciable shrinkage of materials used. A considerable reduction of cost is shown by the more liberal use of brush, and a much greater saving is made by the use of sand for the main body of the dams.

The hydraulic dredge is especially adapted for use in building sand dams either in connection with dredging improvements or for the sole purpose of placing material for the dams without any reference to the advantages usually obtainable in removing the sand from the channel. By very easy adjustments of the direction and elevation of the discharge, the sand delivered from the dredge may be deposited in the desired form of dike to make, without grading, the body of the dams. In this district the deposit is made about 30 feet wide on top with side and end slopes about 1 on 2½, thereby substituting about 2 or 2½ cubic yards of sand for one estimated cubic yard of brush and rock combined. A course of brush and rock laid upon the crest of the deposit, the usual bank protection at the shore end, and a similar protection around the out end slope extending back 30 or 40 feet completes the dam.

The severe test of an unusually long period of high water and the operations of logging companies in gathering and running a vast number of logs over and around the sand dams built in this manner in 1896 seems to clearly demonstrate their stability. The river was cleared of ice very suddenly, at a stage that gave just cause to apprehend injury to these dams, but on examination after the floods had subsided they showed no signs of weakness or damage. A flood stage of 17.5 feet on the United States Engineer gauge at St. Paul occurred in April. In July another flood came, which receded gradually; the minimum stage, 3.2 feet, was recorded at the close of the season.

Works of improvement as projected are most likely to be required during the coming season in the vicinity of Hastings, Sturgeon Slough, and Diamond Island.

Dredging.—Hydraulic dredge *Geyser* began operations July 28, and was employed continuously until November 6. The ample stage of water that prevailed throughout the season permitted a very advantageous selection of work and a more general application of the dredge to the double purpose of simultaneously dredging the channel and building dams.

Below Kaposia Light a cut 1,200 feet long, 100 feet wide, with grade 5 feet below low water of 1864, was made through a sand and gravel bar. The material removed—22,500 cubic yards—was deposited in spoil banks to the left of the channel and for building Dam 56 (sheet 2). In the vicinity of Island 15 material was dredged from the channel and deposited in position for Dams 57 and 58 (sheet 5). A shifting bar of sand at the head of Island 19, which seemed likely to give trouble, was partially removed by making a cut 800 feet long by 100 feet wide through the bar, removing 7,000 cubic yards of sand to spoil banks to the right of the channel above and behind the island. The dredge was then taken to the works at the head of Island 20, and removed from the channel and delivered into dams 16,320 cubic yards of sand, distributed as shown in list of works constructed.

The cost of dredging for the season, including the insignificant cost of delivering a large part of the material dredged into dams, was 6.9 cents per cubic yard.

The entire Government fleet was laid up in the winter harbor at Boulanger Slough November 10.

List of works constructed and repaired and of materials used during the season of 1897 between St. Paul and Lake Pepin.

Designation.	Dimensions.		Material.		
	Length.	Height above low water 1864.	Rock.	Brush.	Sand.
Sheet 1:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Shore protection, left bank at Frenchmans Light, raised and repaired	.....	.....	231.8	.....	.....
Closing dam 25 raised and repaired	.....	6	394.6	438.3	.....
Sheet 1:					
Shore protection, right bank, at Pigs Eye Light, raised and repaired	.....	.....	1,(70.6	.....	.....
Sheet 2:					
Shore protection, left bank, at Quarantine Light, repaired	.....	.....	754.2	.....	.....
Shore protection, left bank, at Quarantine Light, extended	630	.....	901.9	466.7	.....
Wing dam 56	500	7	255.4	177.4	4,570
Shore protection, right bank, opposite island 3, repaired	.....	.....	157.6	.....	.....

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List of works constructed and repaired and of materials used during the season of 1897 between St. Paul and Lake Pepin—Continued.

Designation.	Dimensions.		Material.		
	Length.	Height above low water 1864.	Rock.	Brush	Sand.
Sheet 3:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Closing dam 2, raised	.....	6	388.6	445.4	.....
Shore protection, left bank, below St. Paul Park Bridge, repaired	.....	.....	78.7	.....	.....
Wing dam 3, raised and repaired	.....	5	239	317	.....
Sheet 4:					
Closing dam 3, raised	.....	6	402	583.2	.....
Sheet 5:					
Wing dam 57	530	7	157.1	192.7	2,730
Wing dam 58	400	7	159.3	239.2	1,560
Sheet 6:					
Shore protection, right bank, above Hastings, repaired and extended	360	.....	1,008.8	625.8	.....
Shore protection, left bank, above Hastings, repaired and extended	720	.....	1,010.2	387.9	.....
Shore protection, right bank, below Hastings, repaired	.....	.....	953.5	450.7	.....
Sheet 7:					
Shore protection, right bank, opposite dam 5, extended	550	.....	1,201.3	463.7	.....
Wing dam 2, end raised	.....	.....	82.2	100	.....
Sheet 8:					
Shore protection, right bank, above island 20	2,490	.....	3,259.1	2,446.1	.....
Wing dam 34	250	5.5	257.8	200	1,960
Wing dam 35	340	5.5	326.8	250	3,790
Wing dam 36	700	5.5	336.1	447.3	4,120
Wing dam 37	410	5	514.5	891.6	.....
Wing dam 38	340	5	394.4	602.5	800
Wing dam 39	250	5.5	89.2	150	1,650
Shore protection, right bank, below dam 14	6,125	.....	9,555.3	6,752.9	.....
Wing dam 28	225	5	313.9	874.5	.....
Wing dam 29	500	5	636.5	1,761.2	.....
Wing dam 30	560	5	750.1	1,960.6	.....
Wing dam 31	560	5	761.8	2,116	.....
Wing dam 32	520	5	686.1	1,743.3	.....
Wing dam 33	250	5	236.7	518.4	.....
Shore protection, left bank, above dam 2	2,420	.....	3,506.7	1,937.3	.....
Total	.....	.....	31,071.8	27,539.7	21,180

Financial statement for work of building dams and shore protections between St. Paul and Lake Pepin for the calendar year 1897.

Amount expended in the field during the calendar year	$29,258.42
Add quota of general superintendence and office expenses	922.05
Add for use and deterioration of plant	2,674.04
Total	32,854.51

Materials put in place:		
Rock	cubic yards	31,071.8
Brush	do	27,539.7
Total	do	58,611.5

Average cost per cubic yard:	
On barges	$0 231
For towing and putting in place	.268
For general superintendence and office expenses	.016
For plant	.045
Average cost per cubic yard in place	.560

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Financial statement for dredging between St. Paul and Lake Pepin for the calendar year 1897.

Amount expended in the field during the calendar year	$2,851.99
Add quota of general superintendence and office expenses	99.05
Add for use and deterioration of plant	434.15
Total	3,385.19
Material removed (sand) cubic yards	48,855
Average cost per cubic yard:	
For field operations and expenses	$0.058
For general superintendence and office expenses	.002
For plant	.009
Average cost per cubic yard of sand removed	.069

Very respectfully, your obedient servant,

J. D. DUSHANE, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. W. A. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
La Crosse, Wis., February 15, 1898.

COLONEL: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1897:

CONSTRUCTING A HARBOR IN LAKE PEPIN (KINGS COULEE).

The act of Congress passed June 3, 1896, allotted $30,000 "for the purpose of constructing a harbor of refuge on the west shore of Lake Pepin, Mississippi River, at or near Kings Coulee, between Lake City and Reeds Landing, Minnesota."

The original project for this work, described in my report of last year, was approved July 24, 1896. Owing to the increased durability and appreciable reduction in the first cost to be realized from the substitution of gravel and rock for the proposed ballasted crib work, together with the superior facilities for making subsequent repairs to a pier thus constructed, it was deemed advisable to modify the original project pertaining to the substructure and superstructure of the pier, provided that, upon being tested, the completed portion of the breakwater gave evidence of sufficient strength to resist the force of heavy storms and ice pressure. This having been demonstrated by the excellent condition in which the embankment was found upon the recession of the water in the spring, after a higher stage than any heretofore recorded at the time of the disappearance of the ice in Lake Pepin, it was decided to take advantage of the apparent benefits to be derived from the adoption of this method. Accordingly, under date of April 13, 1897, a modified project was submitted, recommending the adoption of the above modifications and the additional use of brush in the foundation. This project was approved April 26, 1897.

During the spring of 1897 the necessary repairs were made to dredge *Vulcan*, launch *Ada*, and balance of the dredging fleet in Fountain City Bay and Lake City Harbor. Immediately upon completion of these repairs, May 14, the fleet was taken to Kings Coulee, where work was resumed on construction of the pier May 17.

The work was performed by hired labor and use of Government plant. The materials used (gravel, rock, and brush) were furnished as follows: All the gravel was supplied by the U. S. dredge *Vulcan*, with launch *Ada* acting as tender; 6,554.9 cubic yards of rock were purchased in open market under public notices dated May 7 and October 2, 1897, at 40 and 44 cents per cubic yard, loaded on United States barges, and the remainder (27.4 cubic yards) was picked up along the lake shore by hired labor. All the brush was purchased in open market under public notices dated July 29 and September 15, 1897, at 12.4 cents per cubic yard, loaded on United States barges.

During the season 250 linear feet of the pier, 10 feet wide on top and 36 feet wide at low-water line, covered with a heavy riprap from 3½ to 4 feet thick at the bottom

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of the slope, gradually decreasing to 2 feet in thickness at the top, were completed to a height of 12 feet above low water of 1864, and 100 feet more were carried to the reference +3.0, making a total of 500 linear feet entirely completed, and 100 feet additional built to the water surface at a 3-foot stage. The slopes above low water are 13 feet horizontal to 12 feet vertical, and the slopes of the foundation are the natural slopes of good, heavy gravel under water.

There were used in the work 74,474.4 cubic yards gravel, dumped in place; 13,307 cubic yards brush, and 6,582.3 cubic yards rock. Time lost by dredge on account of accidents, storms, etc., 245 hours.

The total amount of material put in place during 1896 and 1897 is as follows: Gravel, 109,041.8 cubic yards; rock, 8,185.4 cubic yards; brush, 13,307 cubic yards.

Operations were suspended November 8, 1897, on account of cold weather, and the entire dredging fleet was placed in winter quarters in Fountain City Bay.

Amount expended during calendar year 1897 (from distribution sheets), $16,202.15. Total amount expended during calendar years 1896 and 1897 (from distribution sheets), $24,505.48.

REEDS LANDING TO TREMPEALEAU.

Under project approved September 4, 1896, and allotment of $50,000, a contract, dated December 24, 1896, was entered into with Fetter & Crosby, of La Crosse, Wis., for the construction and repair of rock and brush dams and shore protections, at 97 cents per cubic yard for rock and 17 cents per cubic yard for brush, in place.

Work under this contract was commenced June 8, 1897, and continued to November 18, 1897, when operations were suspended for the season. Owing to delays from various causes, the contractors were unable to finish their work during the past season, and the time for completion of contract was extended from December 31, 1897, to June 30, 1898, approved by indorsement of Chief of Engineers, dated December 15, 1897.

Improvements were made opposite Crats Island, above Tee-pee-ota Point, below Grand Encampment Island, opposite Alma, and in vicinity of the head of Rollingstone Slough.

Opposite Crats Island (below Wabasha).—The deep water here showed a tendency to follow closely under the end of old Wing Dam 26 (sheet 14), making two very abrupt turns, unfavorable for raft navigation. To correct this fault and give the channel its proper course, four wing dams, Nos. 34, 35, 36, and 42, were built from the Wisconsin shore 600, 1,230, 1,780, and 2,280 feet, respectively, below Dam 26.

Above Tee-pee-ota Point.—Troubles of a more or less serious nature have been experienced in this locality for years, occasioned largely, no doubt, through the action of the sheer boom of the Mississippi River Logging Company. The approved project contemplated, in part, the construction of a series of wing dams from Wisconsin shore opposite the boom, for the contraction of the channel at this point and to throw the water against the boom, but as it was ascertained through extensive correspondence on the subject with Laird-Norton Company that these dams would seriously interfere with the operation of their boom, it was deemed advisable to substitute a lateral dam for the four upper wing dams. Lateral Dam 37 (sheet 14) was built from a point on the Wisconsin shore 4,970 feet above head of Island 31, and extends downstream a distance of 3,170 feet. Wing Dam 38, also built from Wisconsin shore, is 900 feet above Island 31.

Below Grand Encampment Island.—The chief object here was to maintain the channel on the Wisconsin side and to incidentally deepen same by contraction. This was effected by extending two wing dams, Nos. 39 and 40 (sheet 14), from Minnesota shore at intervals of 1,400 feet above old Wing Dam 12, and by building Wing Dam 41 from east side of Island 33, near the foot.

Vicinity of Alma.—A flat, shallow bar has been in formation immediately in front of the town for some time, and the accumulations and deposits of recent years have increased its proportions to such extent as to interfere very seriously with both the channel and steamboat landing. The project proposes extensive improvements in this locality for maintaining the channel along the Wisconsin shore, but, owing to the lateness of the season, little more than a commencement could be made. Two wing dams, Nos. 25 and 26 (sheet 15), were extended from the east side of Island 40, the former 400 feet and the latter 950 feet below head of island. Dam 26 was not completed.

Rollingstone Bar (above Fountain City).—The natural supply of water at this point had been greatly diminished through the immense draft into Rollingstone Slough, a great portion of the water which should have been retained in the channel passing around under the end of Dam 1 (sheet 17) into Rollingstone. This unwarrantable decrease in volume made the current in the channel so sluggish that it was not able to carry the large accumulations of sand to points of safety farther down the stream, and, as a result, an immense bar was formed abreast of Dams 1 and 2. The loss in volume could probably have been restricted, if not entirely checked, by raising

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Closing Dam 4 in Rollingstone Slough, but, as the contractors in this vicinity lacked the necessary plant and equipments for doing this work, it was thought possible to gain the same end by another method. This was done by raising Wing Dam 1, raising and extending Wing Dam 2, then extending the former laterally and joining it to the outer end of Dam 2. Only the upper 330 feet of this lateral extension of Dam 2 were built to the reference +4.0, an apron mat being laid for the remaining 1,100 feet. To further aid in the correction and contraction of the channel at this point, and to promote the scour, two wing dams, Nos. 40 and 41, respectively 1,000 and 1,740 feet above old Wing Dam 19, were built from the Wisconsin shore.

All the above dams were built to a height of 4 feet above low water of 1864, excepting a part of Wing Dam 1. In each instance where work was carried on very satisfactory results were obtained.

Further details as to length and height of works constructed are shown in the accompanying table.

Mr. Louis Shaw was the inspector in local charge of the work.

List of works constructed and repaired, and of materials used, during season of 1897, under contract with Fetter & Crosby, between Reeds Landing and Trempealeau.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 14:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam 34	700	4	1,027.7	2,712
Wing dam 35	600	4	871.3	2,088.9
Wing dam 36	400	4	634.8	1,920.8
Wing dam 37	3,170	4	3,890.2	13,276.8
Wing dam 38	600	4	875.7	4,210
Wing dam 39	1,400	4	1,372.5	4,593.3
Wing dam 40	1,300	4	1,730.9	5,139.7
Wing dam 41	385	4	305.4	971.9
Wing dam 42	300	4	382.3	1,565
Sheet 15:				
Wing dam 25	620	4	1,867	6,656.4
Wing dam 26, commenced	170	4	800.9	3,243.9
Sheet 17:				
Wing dam 1, raised and extended	1,430	0 to 4	3,102.9	14,354.2
Wing dam 2, extended	200	4	743.2	3,307.8
Wing dam 40	425	4	352.5	1,746.7
Wing dam 41	165	4	266.6	1,157.2
Total			18,223.9	66,944.6

Financial statement for work between Reeds Landing and Trempealeau performed under contract with Fetter & Crosby in 1897.

Amount paid contractor		$26,151.97
Retained percentage		2,995.78
Cost of local inspection, etc		1,701.95
Add quota of general superintendence and office expenses		978.17
Add plant charge		99.84
Total		31,837.71
Material put in works:		
Rock	cubic yards	18,223.9
Brush	do	66,944.6
Total	do	85,168.5
Average cost per cubic yard, in place		$0.374

MINNEISKA TO QUEENS BLUFF.

Under project approved July 9, 1897, and allotment of $35,000, a contract, dated September 28, 1897, was entered into with Fetter & Crosby, of La Crosse, Wis., for the construction of dams and shore protection of rock and brush between Minneiska and Queens Bluff, at 98 cents per cubic yard for rock and 19 cents per cubic yard for brush, in place.

No work was done during 1897.

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QUEENS BLUFF TO PRAIRIE DU CHIEN.

(a) *Construction of dams and shore protection.*—The improvement of this section of the river, 88 miles in length, by the construction and repair of rock and brush dams and shore protection, was carried on under projects approved August 22, 1896, and July 9, 1897. Work during the season was performed by hired labor and use of Government plant, towboat *Alert* and launch *Elsie* being used for towing. Brush loaded on United States barges was purchased in open market, under public notices dated June 2 and September 15, 1897, at 12½ cents per cubic yard. The rock used was procured as follows: 2,677.1 cubic yards sand rock and 6,065.6 yards lime rock were purchased in open market under public notice dated June 19, 1897, at 31½ cents per cubic yard for sand rock and 44½ cents per cubic yard for lime rock, on United States barges. The remainder of the lime rock, 42,532.2 cubic yards, was quarried and loaded on United States barges by hired labor and use of Government plant.

The serviceable portion of the fleet quartered in Fountain City Bay was transferred to Coon Slough between June 21 and June 26, 1897, on which latter date field operations were resumed in vicinity of Warners Landing. The work was much retarded during the earlier part of the season on account of high water and the consequent difficulties attending the collection and delivery of the material required in the prosecution of the work, but later on, as the water receded and the conditions became more favorable, rapid and successful progress was made.

Improvements and repairs were made in the following localities: Vicinity of Winona, Richmond Island, Dakota, La Crosse, Picayune Island, and Coon Slough.

Vicinity of Winona.—Closing Dams 1 and 20 (sheet 18), the former across Blacksmith Slough and the latter between Islands 71 and 72, were raised and repaired.

Vicinity of Richmond Island.—A detached portion of the fleet, consisting of launch *Elsie*, quarter boat 75, building boat 97, and 9 barges, was taken to Richmond Island August 17, where operations were resumed for the completion of the system of dams commenced in that vicinity during season of 1891, with a view of securing a permanent channel along the east side of the island. This work embraced the construction of five new wing dams, the extension of three others, and the extension of the Richmond Island shore protection. The dams were built as follows: Wing Dam 47 (sheet 18) from Minnesota shore, 780 feet above old Dam 14; Wing Dam 48 from west side of Island 87, 675 feet above Dam 12; Wing Dams 49 and 50 from left bank, at intervals of 800 feet above old Dam 16, and Wing Dam 51 from left bank 800 feet below Dam 16. Wing Dams 14, 15, and 16 were raised and extended to the projected length. Old Wing Dam 46 was repaired at shore end. The east bank of Richmond Island was put in condition to partially resist the increased force and velocity of the current naturally following the contraction of the channel, by sinking 4,400 linear feet of matting along the shore of the island to the reference +3.0.

Vicinity of Dakota.—Old Closing Dam 6 (sheet 20) at the head of Island 93 was raised, and the detached end connected with the head of the island. Island 93 was protected around head and on west side a distance of 700 feet.

Vicinity of La Crosse.—Closing Dams 1 and 41 (sheet 22), the former closing Broken Arrow Slough and the latter across Sand Slough, were raised and repaired. Broken Arrow Island was protected around the head and on east side. Three thousand three hundred feet of this shore protection were completed, and 2,700 additional feet of matting were sunk, the bank of the upper 1,700 feet of this latter distance being graded and partly rocked.

Vicinity of Picayune Island.—Some improvements were made here during 1893, and with good results, but owing to a division of the river at Picayune Island, making it difficult to determine whether the channel should go to the right or left of the island, it was deemed advisable to postpone the completion of this work until such time as the river itself should indicate a preference. During recent years the water showed a manifest tendency to follow the Minnesota shore through Picayune Chute, and to further this inclination, it was decided to extend the series of wing dams from the Wisconsin shore, thereby confining the channel to the regulation width and at the same time insuring the ultimate removal of Picayune Island through the action of the current. Four wing dams, Nos. 17, 19, 21, and 22 (sheet 22), all from the left bank, were raised and extended. The Minnesota shore was protected by matting from mouth of Root River to foot of Picayune Chute, a distance of 9,800 feet, and the bank was partly graded and rocked.

Vicinity of Coon Slough.—Considerable shore protection was built in the concave bends of the slough during 1895, and proved very effective in places where completed, but the great velocity of the current, due to the contracted width of the river, endangers all the banks along the slough, and it will eventually become necessary to protect boths sides nearly the entire length. As it was impracticable to do all this in a limited space of time, only the most exposed points received attention last season. Protections were built on right bank below Middle Slough, at island in Big Bend, and right bank opposite Warners Landing, their respective lengths being 600, 1,450, and 2,600 feet. One thousand six hundred and sixty-five feet

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of matting were sunk in continuation of shore protection opposite Britts Landing, and the bank was partly rocked. Closing Dam 12 (sheet 23) received slight repairs. A gap 170 feet long in shore protection, Island 126, below Genoa, was repaired, and Closing Dam 1 (sheet 24), to the left of same island, was strengthened at shore ends.

All dams built or extended were carried to a height of 4 feet above low water of 1864.

Operations were suspended November 9, 1897, and the fleet placed in winter quarters in Fountain City Bay.

Works of improvement should be made in vicinity of Alma, Minneiska, Mount Vernon, Dresbach, Trempealeau, and Grand Crossing. The following series of dams should be extended: Right bank below Chimney Rock; opposite Fountain City; below Chicago, Burlington and Northern Railroad bridge at Winona, and opposite Broken Arrow Island. Shore protections should be extended opposite Island 29, at Islands 55, 58, and 96, Grand Island, Islands 113 and 116, and Coon Slough. Shore protection should be built above Buffalo Slough; opposite Island 55; at Island 63; Winters Landing; and below Root River. Closing dam across Rollingstone Slough should be raised.

List of works constructed and repaired and of materials used during the season of 1897 between Queens Bluff and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cubic yds.*	*Cubic yds.*
Sheet 18:				
Closing dam 1, repaired	.....	4	104.3	454.5
Closing dam 20, repaired	.....	4	604.2	2,114.1
Sheet 19:				
Wing dam 14, raised and extended	248	4	582.5	2,306.9
Wing dam 15, raised and extended	25	4	511.7	3,325.8
Wing dam 16, raised and extended	85	4	335.1	2,498.6
Wing dam 46, repaired	.....	.....	109.1	555.4
Wing dam 47	700	4	555.1	3,311.6
Wing dam 48	400	4	579.9	3,079.6
Wing dam 49	750	4	778.5	5,306.4
Wing dam 50	820	4	593.2	4,713.6
Wing dam 51	800	4	943.7	6,987.6
Shore protection, Island 86, commenced	4,400	.....	1,162.6	7,839.4
Sheet 20:				
Closing dam 6, raised and repaired	.....	4	1,576.1	8,012.4
Shore protection, Island 93, rebuilt	700	.....	702.6	1,405.2
Sheet 22:				
Closing dam 1, raised and repaired	.....	4	637.9	1,538.1
Wing dam 17, raised and extended	160	4	1,878.1	4,040.2
Wing dam 19, raised and extended	535	4	2,735.1	5,481
Wing dam 21, raised and extended	510	4	2,322.5	5,506.6
Wing dam 22, raised and extended	380	4	1,959.5	4,448.8
Closing dam 41, raised and repaired	.....	4	1,258.4	1,845.1
Shore protection "K" (Root River), commenced	9,800	.....	7,003.5	16,210.1
Shore protection "L" (Broken Arrow Island), commenced	6,000	.....	13,363.4	25,654.5
Sheet 23:				
Closing dam 12, repaired	.....	.....	108.2	.....
Shore protection "G" (opposite Britts Landing)	1,665	.....	2,196.9	4,614
Shore protection "H" (Big Bend)	1,450	.....	3,508.5	6,033.1
Shore protection "I" (opposite Warners Landing)	2,600	.....	3,512.5	3,881.7
Shore protection "J" (Middle Slough)	600	.....	1,214.3	1,673.4
Sheet 24:				
Closing dam 1, repaired	.....	.....	205.4	.....
Shore protection, Island 126, repaired	.....	.....	732.1	1,239.9
Total	.....	.....	51,274.9	134,077.6

Financial statement for work of building dams and shore protection between Queens Bluff and Prairie du Chien, performed by hired labor, during season of 1897.

Amount expended in field during calendar year 1897 (from distribution sheets)		$64,147.95
Add quota for general superintendence and office expenses		2,039.90
Add for use and deterioration of plant, quarry	$2,438.02	
Add for use and deterioration of plant, building dams, etc	5,627.41	
		8,065.43
Total		74,253.28

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Material put in works:		
Rock	cubic yards..	51,274.9
Brush	do....	134,077.6
Total	do....	185,352.5
Average cost per cubic yard:		
On barges		$0.209
For towing and putting in place		.137
For general superintendence and office expenses		.011
For plant		.044
Average cost per cubic yard in place		.401

(*b*) *Quarrying rock at Britts Landing, Wisconsin.*—Work was performed by hired labor and use of Government plant, the cable hoist being employed in the transportation of the rock from quarry to barges. Rand and Ingersoll-Sargent steam drills were used for drilling.

The ground on which the quarry is located was rented under lease dated August 1, 1895, and approved August 27, 1895, at an annual rental of $300.

Some minor changes and necessary repairs were made to the hoist before same was placed in commission. The alterations and additions were as follows: The old cast-iron driving pinion was replaced by a steel pinion. Two extra crank-shaft bearings were put inside of engine frame and heavier eccentric straps were substituted for the old ones. Additional timber work was built on top of head tower and two 48-inch sheaves were put in place of the 30-inch sheaves. The old ⅞-inch hauling line was replaced by 1,000 feet of 1-inch wire rope. Two Rand steam drills and three Wells lights were added to the plant in the quarry. New quarters, large enough to accommodate about one hundred men, were erected in the northwest section of the quarry and furnished with a complete outfit.

Operations were commenced June 24, 1897, and continued with but slight interruptions until November 6, when work was discontinued on account of cold weather. The supply of rock on the old floor of quarry having become pretty thoroughly exhausted, a new cut was opened on the south side of the tower about 11 feet below the former level, and another cut, 26 feet below the original quarry floor, was made on the north side. From August 19 to close of season two shifts of men were employed, each working eight hours per day, the cable hoist being operated sixteen hours per day. The large output following the adoption of this system resulted in materially reducing the proportionate cost of fixed charges, such as superintendence, rent, etc., and the comparatively low average cost per cubic yard attained may be largely attributed to this cause. In this connection I would respectfully call attention to the appreciable reduction in the cost per cubic yard from month to month, as given in the following table:

Statement showing amounts quarried per month, the total cost, and average cost per cubic yard loaded on barges.

Month.	Number of cubic yards.	Total cost.	Average cost per cubic yard.
June and July	7,223.6	$4,428.49	$0.6130
August	7,407.1	3,476.28	.4693
September	11,410.5	4,969.63	.4354
October and November	16,491.0	5,878.98	.3565
	42,532.2	18,753.38	.4409
Add for use and deterioration of plant	.....	2,438.02	.0573
Total	42,582.2	21,191.40	.4982

LA CROSSE HARBOR.

The act of June 3, 1896, allotted $5,000 for this harbor, but, as the results of a survey ordered by the same act were such as to show that about $17,000 would be needed to perform the required work, the amount allotted was not deemed sufficient to justify a commencement and it was thought better to reserve the $5,000 until further funds become available.

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CARE, REPAIR, AND CONSTRUCTION OF PLANT.

Repair and construction of plant were carried on during the season, by hired labor, at Lake City, at boat yard in Fountain City, and at Britts Landing, Wisconsin. New quarry quarters, 1 quarter boat, and 1 barge were built. Towboat *Alert*, launches *Ada* and *Elsie*, dredge *Vulcan*, 2 quarter boats, 2 dump boats, 1 building boat, 1 grasshopper, 12 barges, 4 skiffs, and the cable hoist were repaired. At such times as the plant was not in commission watchmen were employed in caring for same.

The cost of care, repair, and construction of plant was $11,429.96, of which amount $1,483.63 was paid from allotment for Kings Coulee.

Respectfully submitted.

W. A. THOMPSON, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. J. C. M'ELHERNE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 31, 1898.

COLONEL: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1897:

REMOVAL OF BARS AT DUBUQUE.

Under project approved July 9, 1897, and appropriation of $30,000 made by the sundry civil act of June 4, 1897, a contract dated September 16 was entered into with Charles H. Appleton for the removal of material from ice harbor and bars at Dubuque, Iowa, at 14 9/10 cents per cubic yard.

Within the ice harbor sediment had been largely deposited, making it a difficult matter for boats of deep draft to enter the harbor or closely approach the interior shores during low stages of water; and abreast of the city a high bar had formed, extending from the upper side of the harbor down to a point well below the steamboat landing, leaving insufficient room for navigation along the levee front. For the purpose of removing those obstructions dredging was commenced in the former place on August 20, 1897, and carried over a section 360 feet wide, reaching from deep water outside of mouth of harbor well up into the same—an average distance of 670 feet. In the latter locality the entire west side of the bar was taken off to an average width of 320 feet. A minimum depth of 4½ feet was secured over a total area of 363,000 square feet. Work thereon was discontinued for the season on November 26.

Thomas B. Downer served as inspector on the work and discharged his duties very efficiently.

Financial statement for work on ice harbor and bars at Dubuque, Iowa, performed under contract with C. H. Appleton during the season of 1897.

Amount paid contractor		$9,545.03
Add retained percentage		1,060.55
Add cost of inspection, etc		488.95
Total		11,094.53
Amount of material removed	cubic yards..	71,178.4
Cost per cubic yard		$0.156

DUBUQUE TO CLINTON.

Under project approved September 4, 1896, and allotment of $35,000 from appropriation of July 19, 1897, the expenditure having been previously authorized by act of June 3, 1896, a contract dated December 14, 1896, was entered into with Albert Kirchner for the construction of brush and rock dams and shore protections, at 17 cents per cubic yard for brush and 90 cents per cubic yard for rock in place.

Operations thereon were begun on April 29, 1897, and the placing of the material was finished by July 7; but the proper surface dressing of the work, which a high stage of water prevented, was temporarily postponed and was not entirely completed until October 7, 1897.

At head of Island 241.—Dam No. 21 (sheet 38) was built across Stone Slough to close off a heavy side draught of water, and the shoulder of the island itself was

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protected from the dam to the lower end of the caving bank, the average width being 48 feet.

In vicinity of Bellevue.—To improve the very flat, shoal, troublesome crossing just below that city dams were constructed, viz: Nos. 3, 4, 5, and 6 (sheet 39) from Iowa shore well over on to large bar below Island 248, No. 7, out from foot of same island, and Nos. 8, 9, and 10 at Illinois side of river, a short distance farther down, the latter one being a closing dam across a little chute. Immediately below these dams the long cutting bend in Illinois shore was protected to an average width of 56 feet. The channel way in this locality having been greatly narrowed and properly straightened by these dams was thereby notably deepened and benefited.

In vicinity of Fulton.—The Illinois shore above Upper Cat Tail Slough having continued to suffer greatly from erosion, the protection was extended from the end of the old work up river to a point abreast of willow bars below Island 286, the average width being 45 feet. A closing dam, No. 12, sheet 43, was built across a small chute near lower end of the protection.

C. H. Sisson performed the duties of inspector in a very satisfactory manner.

List of works constructed and material used during season of 1897, under contract with Albert Kirchner, between Dubuque and Clinton.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 38:	*Feet.*	*Feet.*	*Cub. yards.*	*Cub. yards.*
Closing dam 2	260	3	1,605	1,697
Shore protection on shoulder, Island 241	1,175	.....	2,764.2	2,309.4
Sheet 39:				
Wing dam 3	1,255	3	2,687.1	3,750.4
Wing dam 4	900	3	2,666.1	4,449.4
Wing dam 5	365	3	632.7	817.7
Wing dam 6	470	3	1,830.9	2,151.6
Wing dam 7	455	3	1,207.1	1,632.4
Wing dam 8	350	—5	1,090.2	1,178.5
Wing dam 9	780	3	2,157.6	2,921.5
Closing dam 10	30	7	150.9	150
Shore protection, Illinois shore below Island 248	2,820	.....	7,011.5	6,355.8
Sheet 43:				
Closing dam 12	35	7	178.5	185
Shore protection, Illinois shore below Island 286	2,340	.....	5,741.2	4,975.7
Total	.....	.....	29,673	32,574.4

Financial statement for work between Dubuque and Clinton, performed under contract with Albert Kirchner during season of 1897.

Amount paid contractor	$32,243.35
Cost of inspection, etc	921.26
Add quota of general superintendence and office expenses	1,054.65
Add for use and deterioration of plant	38.11
Total	34,257.37
Material put in works:	
Rock, cubic yards	29,673
Brush, do	32,574.4
Total, do	62,247.4
Average cost per cubic yard in place	$0.550

DUBUQUE TO LECLAIRE.

Under project approved July 9, 1897, and allotment of $35,000, a contract dated September 18, 1897, was entered into with George W. Farley & Co. for the construction of brush and rock dams and shore protections, at 32 cents per cubic yard for brush and 69 cents per cubic yard for rock in place.

Work was commenced on September 23, 1897, and at the near approach of wintry weather, on November 16, was discontinued for the season.

The shoulder of Nine Mile Island, No. 232, which has continued for years to wear

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away rapidly, was protected from its head down to lower end of the cutting section, for an average width of 52 feet. Opposite this point, in bend on Illinois side of river, where an objectionable chute existed and the adjacent banks were caving badly, Closing Dams No. 7 and 8 (sheet 37) were built, the former from foot of Island 231 to a towhead in upper end of the chute, and the latter from this towhead to a little island immediately below it. The heads and shoulders of both towheads and islet were protected, their average widths being 30 and 44 feet, respectively.

C. B. McClure acted as inspector on the work and gave good satisfaction in the performance of his duties.

List of works constructed and material used during season of 1897, under contract with George W. Farley & Co., between Dubuque and Leclaire.

Designation.	Dimensions.		Materials.	
	Length.	Height above low water, 1894.	Rock.	Brush.
Sheet 37:	*Feet.*	*Feet.*	*Cub. yards.*	*Cub. yards.*
Shore protection on shoulder of Island 232	2,825	.....	4,455.4	7,733.7
Closing dam 7	60	8	134.2	205.6
Closing dam 8	100	8	125.8	171.9
Shore protection on towhead below Island 231	360	.....	262	482.1
Shore protection on island below Island 231	120	.....	126.7	227.3
Total	.....	.....	5,104.1	8,820.6

Financial statement for work between Dubuque and Leclaire, performed under contract with George W. Farley & Co., during season of 1897.

Amount paid contractor	$5,709.98
Add retained percentage	634.44
Add cost of local inspection, etc	473.72
Add quota of general superintendence and office expenses	216.81
Add for use and deterioration of plant	19.24
Total	7,054.19
Material put in works:	
Rock, cubic yards	5,104.1
Brush, do	8,820.6
Total, do	13,924.7
Average cost per cubic yard in place	$0.507

IN VICINITY OF CLINTON.

Four log cribs, filled with rock and built by a lumber firm some years ago in edge of channel in front of Clinton, were reported last spring by river men as being dangerous obstructions to navigation.

The dredge *Ajax*, with the towboat *Ruth* as a tender, between June 1 and 9, 1897, inclusive, totally removed those cribs to a depth of 5 feet at low water, the total area covered by their bases being about 8,000 square feet.

The large timbers, logs, etc., when torn loose were towed ashore by the natives, but the rock taken out, to the amount of 1,280 cubic yards, was utilized in thoroughly repairing the old shore protection around the head and sides of Wil ow Island, opposite Island 290.

IMPROVING ROCK ISLAND RAPIDS.

Such boats of the fleet as were required for early service having been overhauled and put in thorough repair, field operations were resumed on May 26, 1897, beginning at Duck Creek and Cottonwood chains.

Dams.—No. 8¼ (sheet 47) in head of Sucker Chute was widened and raised in a submerged form for the purpose of still further checking the strong draft in that direction. No. 6¼ at Winnebago Chain and No. 8 in Campbells Chute had their aprons partly renewed where damage had been sustained, and No. 9¼, opposite the mouth of Duck Creek, received additional material to prepare it the better to withstand sudden heavy floods from that stream. Dam No. 11, having suffered very

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severely from last winter's enormous ice gorge, which carried away the top of this dam at the outer end for a distance of 400 feet and in places greatly injured the remaining long section, was repaired, and widened where necessary, except the large break which, instead of being entirely built up to the original height, was raised only to low-water elevation. This part was, however, protected in that shape by a heavy brush mat, and left so temporarily to aid in observing the effect produced on Duck Creek Chain during the lowest water of the season by the various dams constructed in the immediate vicinity. Dam No. 20, located a short distance below Duck Creek Chain, was built from Illinois shore to intersect with outer end of Dam 18. To afford it some protection from the ice a thick brush mat was placed along the dam its full length on the upstream side. The lower end of Trailing Dam No. 11½ for a distance of 800 feet having been taken out, the material obtained therefrom was also placed in this dam. Dam No. 21, from a point at Iowa shore 750 feet below Dam No. 16, was carried on to partial completion in two submerged sections, one being across the deep, narrow steamboat channel near the Iowa shore and the other over little scattering chutes 700 feet farther out in midriver.

As a result of work done, Duck Creek Chain has been put in fair condition, and the current over the submerged dams below it has been greatly modified by Dam 21, which remains unfinished.

Rock excavation.—Two steam drill boats with double crews were operated. Drill boat No. 6, between June 19 and July 9, outlined and swept over the entire channel from Lower Chain to the foot of the rapids, a distance of 4,000 feet. Many patches, some of them being extensive ones, were found, ranging from 0.5 to 1½ feet above grade; but, in order to work where most needed, only the very small and more dangerous ones, together with the bottom course, 2 feet in height, of a pier of the old Chicago, Rock Island and Pacific Railroad Bridge, were blown up and raked into surrounding deep water. The sum of the areas blasted averaged 1 foot above grade and covered 3,016 square feet. From July 10 to October 15 the channel between the lower ends of Sycamore and Crab Island chains received close attention. As this reach, long complained of by river men, was narrow, crooked, shoal, and very difficult to navigate during low stages, the south half and seven-eighths of the north half of the section, averaging 1.3 feet above grade and covering an area 44,800 square feet, were satisfactorily blasted. Between October 16 and November 6 work on the high projecting shoulder, much in the way of rafts, at upper side of entrance to head of Moline Pool, was vigorously advanced and the boat was then detailed for service elsewhere. The area blasted averaged 4.3 feet above grade and covered 10,490 square feet.

Drill boat No. 103, between May 26 and June 21, performed occasional minor duties as needed, such as establishing anchor bolts for buoys, moorings at dams, water gauges, range poles, etc. From June 22 to August 11, operated in Cottonwood Chain on three high patches averaging 1 foot above grade with an area of 23,600 square feet. August 12 to September 29, blasted upper shoulder of south side of Campbells Chain; height above grade, 1.9 feet; area covered, 24,140 square feet. September 30 to October 15, worked on lower end of shoulder at Dam 16 over an area 2.5 feet above grade, covering 4,450 square feet; then discontinued there, put in 1½ days at reblasting in Winnebago Chain, and worked the remainder of the time until November 28 at disrupting the high projecting shoulder above entrance to head of Moline Pool. Average height of same above grade 1.5 feet, and area 23,320 square feet.

Dredging.—The dredge *Ajax*, with double crew, began on May 28 at removing blasted material from large abrupt shoulder at Dam No. 16, and, with the exception of nine days spent in other service up river, continued there until the completion of that task on July 13. The boat next utilized the time until July 20 gathering up débris from Cottonwood Chain, was engaged taking out lower end of Dam No. 11½ until the 31st, and then returning to Cottonwood Chain effected, by August 9, the removal of what material was so far prepared in that locality. From August 10 to 20 a deep bank of débris was taken from the south side of Crab Island Chain, when, having caught up with the drill boat, the upper shoulder of Campbells Chain was worked upon until the 24th. The Cottonwood Chain patches were then again visited and cleaned up by September 8, after which the material recently blasted in both sides of Crab Island Chain was removed. Finally, between October 26 and November 27, a greatly scattered area of former reblasting in the north side of Winnebago Chain was carefully gone over and reduced to grade.

Guide piers.—The foundations of many of the piers on the upper end of the rapids, having been worn away to some extent within the last few years by the action of the ice and flood, were examined and supplied with an amount of rock sufficient to give them good, large, and fairly durable bases.

All material obtained from both quarry and dredge was utilized in the construction of the various works.

Operations were closed for the season on November 29, and the fleet was then safely harbored in Moline Pool for the winter.

To Mr. J. B. Gordon, overseer on the works, much credit is due for efficiency in the performance of his duties.

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Details of operations, season of 1897.

Towboat *Ruth:*	
Hours in use under steam	1,784¼
Miles run light	2,411
Miles run towing	3,802
Miles run, total	6,213
Towboat *Mac:*	
Hours in use under steam	1,166¼
Miles run light	1,739
Miles run towing	5,090
Miles run, total	6,829
Drill boat No. 6:	
Hours worked	1,926
Hours lost owing to rafts	2
Hours lost owing to accidents	0
Hours lost owing to storms	0
Holes drilled	3,232
Holes blasted	3,075
Linear feet of holes drilled	12,701.2
Range poles set out in rock bottom	146
Ringbolts set	6
Water gauges set	0
Solid cubic yards blasted	3,079.3
Cubic yards broken rock raked into deep water	62.8
Pounds rackarock used	7,221
Drill boat No. 103:	
Hours worked	2,220
Hours lost owing to rafts	24
Hours lost owing to accidents	1
Hours lost owing to storms	0
Holes drilled	3,641
Holes blasted	3,400
Linear feet of holes drilled	14,861.2
Range poles set out in rock bottom	209
Ringbolts set	19
Water gauges set	0
Solid cubic yards rock blasted	4,367.3
Cubic yards broken rock raked into deep water	0
Pounds rackarock used	11,527
Dredge *Ajax:*	
Hours working	2,294
Hours lost owing to rafts	10
Hours lost owing to accidents	46
Hours lost owing to storms	1
Solid cubic yards rock dredged and removed	3,104.9
Cubic yards loose rock and bowlders dredged and removed	17,755

Summary of total amounts of material.

Solid cubic yards rock blasted	7,446.6
Solid cubic yards rock dredged and removed	3,104.9
Cubic yards loose rock and bowlders dredged and removed	17,817.8

Cost of rock excavation, including charge for use and deterioration of plant.

Designation.	Rock excavated (solid cubic yards).	Total cost.	Average cost per solid cubic yard.
Crab Island Chain, removed	2,117.0		
Campbells Chain, removed	305.0		
Winnebago Chain, removed	18.2		
Cottonwood Chain, removed	601.9		
Reach below Lower Chain, removed	62.8		
Total	3,104.9	$13,382.12	$4.310
Campbells Chain, blasted only	1,151.3		
Shoulder below Cottonwood Chain, blasted only	393.8		
Shoulder at head of Moline Pool, blasted only	2,796.6		
Total	4,341.7	14,172.36	3.264
Grand total	7,446.6	27,554.48	

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Cost of repairs to old piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Total cost.	Cost per cubic yard.
Riprap stone in place	3,065.4	$2,604.75	$0.85

List of dams and of material used in their construction and repair during season of 1897.

Designation.	Total length.	Riprap.	Brush.
Sheet 47:	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam No. 6½, widened	830	908.1	.....
Closing dam No. 8, widened	750	1,266.6	.....
Wing dam No. 8½, widened and raised	200	516.2	.....
Wing dam No. 9, widened	535	135	.....
Trailing dam No. 9½, widened	1,250	2,059.6	.....
Trailing dam No. 11, widened	1,710	6,903.6	334.4
Wing dam No. 20	1,600	9,252.8	1,918.5
Wing dam No. 21, commenced	.....	6,462.9	.....
Total	.....	27,504.8	2,252.9

Cost of dams, including charge for use and deterioration of plant.

Material.	Cubic yards.	Total cost.	Cost per cubic yard.
Riprap rock in place	27,504.8	$23,371.59	$0.85

Financial statement for improvement of Rock Island Rapids for season of 1897.

Amount expended in field	$46,338.90
Add quota of general superintendence and office expenses	1,473.58
Add for use and deterioration of plant	5,718.34
Total	53,530.82

Distributed as follows:

1. Rock excavated and removed	13,226.87
2. Rock broken up but not removed	14,327.61
3. Dams 6½, 8, 8½, 9, 9½, 11, 20, and 21	23,371.59
4. Guide piers 1½, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 16	2,604.75
Total	53,530.82

BUOYS ON ROCK ISLAND RAPIDS.

The buoys were first substantially repaired and painted and then reset, as the high water gradually receded and occasion required, between May 23 and June 26, 1897. The range posts also were in the meantime repainted and removed, wherever such action was found necessary. Later on the buoys were taken out, nicely prepared with the various regulation colors specified for service on each side of the channel, and again properly replaced. During the season 6 buoys torn from their moorings were reset twice, and 3 old chains and 2 new ones were put in place. There are now 31 buoys in the system. Between October 30 and November 1 the range posts were again gone over, readjusted, and replaced where found missing, and on the 15th the buoys were gathered up and stored with the fleet for the winter.

Cost of buoyage for the season, $380.

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IMPROVING ROCK ISLAND HARBOR.

In this locality, under project approved August 22, 1896, and the unexpended balance of appropriation made by river and harbor act of June 3, 1896, operations were carried on by hired labor and use of Government plant.

From March 22 to April 12, 1897, a range of ledge rock left unfinished at close of last season, and which to a depth of 1 foot occupied a space 60 feet wide by 102 feet in length, was blown up by drill boat No. 6, and between April 8 and May 27, the dredge *Ajax* satisfactorily removed all the débris prepared by blasting. The section worked over extended along shore, immediately in front of the Diamond Jo Landing, for a distance of 400 feet; reached riverward to deep water, or about 100 feet; was excavated to a depth of 4 feet at low water, and covered an area of 23,096 square feet. Material to the amount of 3,850 cubic yards was dredged out and disposed of in the repair and construction of dams in the immediate vicinity.

An unusually high stage of water prevailing throughout the entire period, greatly interfered with progress and added very materially to the cost of the work.

Financial statement for improvement of harbor at Rock Island during the season of 1897.

Amount expended in field	$1,313.34
Add for use and deterioration of plant	538.15
Total	1,851.49
Amount of solid rock blasted and removed.....cubic yards...	375
Average cost, blasted and removed, per solid cubic yard	4.94

Very respectfully submitted,

J. C. McELHERNE, *U. S. Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 27, 1898.

COLONEL: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1897:

ROCK ISLAND TO MUSCATINE.

Under project approved September 4, 1896, and allotment of $30,000 from appropriation of June 3, 1896, a contract, dated December 14, 1896, was entered into with Patterson Brothers for the construction of brush and rock dams and shore protections, at 84 cents per cubic yard for rock, and 23 cents per cubic yard for brush, in place. Operations were begun June 7, 1897, and continued until the contract was completed September 20.

Vicinity of Credit Island and Rock River.—Three wing dams were built from the Illinois shore and one from the Iowa side. These dams will assist in increasing and maintaining the good work of the dams built in 1895 and 1896.

Vicinity of Montpelier.—From the island shore opposite Montpelier six wing dams were built, with the view of cutting off a side channel and securing contraction in width of waterway. The depth of channel water was at once increased.

Vicinity of Fairport.—The crossing at Fairport becoming shoal, Wyoming Chute and the small chute between Island 329 and 332 were closed, and under another contract a wing dam from the Iowa shore was built. These works will doubtless have good effect.

Miscellaneous.—A landing pier was built at Andalusia. Some additions and repairs were made to shore protection on Island 321. At Muscatine 430 linear feet of shore protection were built, and at Hershey Chute 155 feet.

Mr. J. A. Macfie, the local inspector, gave excellent satisfaction in all branches of his work.

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List of works constructed and of materials used during season of 1897, under contract with Patterson Brothers, between Rock Island and Muscatine.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 48:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam 9	530	3	1,059.5	1,053
Wing dam 10	1,000	3	2,822.5	3,168.3
Wing dam 11	1,430	3	2,395.1	3,134.2
Wing dam 12	480	3	1,158.3	1,270.4
Sheet 49:				
Andalusia Pier	240	5-9	1,297	325.4
Shore protection, Island 321, extended	470	.....	602.6	503.1
Sheet 50:				
Wing dam 5	540	3	2,083.9	2,208.7
Wing dam 6	500	3	1,912.4	2,472.9
Wing dam 7	500	3	1,560.9	1,886.4
Wing dam 8	440	3	1,437.9	1,851.2
Wing dam 9	370	3	1,431.7	2,054.9
Wing dam 10	390	3	1,555.9	2,198.9
Sheet 51:				
Closing dam 10	347	4	1,378.3	988.2
Closing dam 11	1,260	4	4,331.2	3,261.8
Shore protection, Island 331, repaired	155	.....	366	244.8
Sheet 52:				
Shore protection at Muscatine	430	.....	493.9	.....
Total	.....	.....	26,122	26,622.2

Total length of dams built, 8,027 feet; of shore protection, 1,055 feet.

Financial statement for work between Rock Island and Muscatine, performed under contract with Patterson Brothers, during 1897.

Amount paid contractor		$28,065.59
Cost of local inspection, etc		878.78
Add quota of general superintendence and office expenses		920.42
Add for use and deterioration of plant		38.48
Total		29,903.27
Material put in work:		
Rock	cubic yards	26,122
Brush	do	26,622.2
Total	do	52,744.2
Average cost per cubic yard in place		$0.567
Average cost per cubic yard for inspection		.017

Inspector Macfie has endeavored to ascertain the actual cost of this work to the contractor, and gives the following results:

Materials on barges	per cubic yard	$0.311
Pay rolls, fuel, etc., of towboat	do	.043
Putting in place	do	.072
Use of plant	do	.044
Lath yarn, anchor mats, etc	do	.010
Total	do	.480

This shows a profit on this contract of $2,748.37. The contractor paid 42½ cents per cubic yard for rock and 20 cents per cubic yard for brush on barges. He paid laborers $1.50 per day.

ROCK ISLAND TO KEITHSBURG.

Under project approved July 9, 1897, and allotment of $50,000 from appropriation of June 4, 1897, a contract, dated September 22, 1897, was made with Patterson Brothers for the construction of brush and stone dams and shore protections, at 80 cents per cubic yard for rock and 20 cents per cubic yard for brush, in place.

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Contractor began operations September 20, 1897, and closed down for the winter on November 16. The work, which was scattered, consisted in the building of a long wing dam from the Iowa shore below Fairport, in continuation of the system of dams at that locality; two closing dams at small chutes near foot of Hershey Slough; 400 feet of shore protection at Illinois City Landing, and 1,000 feet above Port Louisa.

Great improvement in channel was noted at Fairport, resulting from the work of this and the last two years.

Mr. J. A. Macfie was the local inspector.

List of works constructed and of materials used during the season of 1897, under contract with Patterson Brothers, between Rock Island and Keithsburg.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 48:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam 11, trimmed	.....	8	269.7	.....
Sheet 49:				
Andalusia Pier	.....	.....	107.7	.....
Sheet 50:				
Wing dams 5–10, trimmed	.....	.....	522.1	.....
Sheet 51:				
Closing dam 11, repaired	.....	.....	978	477.8
Wing dam 12	2,150	8	5,250.4	6,137.4
Closing dam 13	300	4	1,354.6	1,114.7
Closing dam 14	130	4	820.4	433.3
Shore protection, Illinois City Landing	700	.....	1,170.4	936.5
Shore protection, foot of Hershey Chute	400	.....	621.2	364
Sheet 53:				
Shore protection above Port Louisa	1,000	.....	2.037	1,499.9
Total	.....	.....	13,131.5	10,963.6

Total length of dams built, 2,580 feet; of shore protection, 2,100 feet.

Financial statement for work between Rock Island and Keithsburg, performed under contract with Patterson Brothers during 1897.

Amount paid contractor	$12,697.92
Cost of local inspection, etc	473.28
Add quota of general superintendence and office expenses	418.84
Add for use and deterioration of plant	20.69
Total	13,610.73
Material put in work:	
Rock, cubic yards	13,131.5
Brush, do	10,963.6
Total, do	24,095.1
Average cost per cubic yard in place	$0.565
Average cost per cubic yard for inspector	.019

HARBOR AT ROCK ISLAND.

In the spring of 1897 dredge *Ajax* was employed for a short time in removing broken rock at Rock Island Harbor. A portion of the Rapids fleet was employed in placing this rock on Dam 1 (sheet 48) and in building Dam 8½. The cost of this work was $3,635.

HARBOR AT MUSCATINE.

The sundry civil act of June 4, 1897, appropriates $15,000 for removing sand bar at Muscatine. The project approved July 9, 1897, proposes the removal by dredge, to a depth of 6 feet at low water, of all sand and other material along the city front.

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Contract was let to A. J. Whitney, dated September 8, 1897, at 15 cents per cubic yard. He commenced work with one dredge and two dump boats on September 13, and closed for the winter November 11. Sections B, C, and D were brought to grade by the removal of 26,173 cubic yards material.

Financial statement for dredging at Muscatine under contract with A. J. Whitney in 1897.

Amount paid contractor	$3,925.95
Superintendence, office, and inspection	371.63
Total	4,297.58
Amount of material removed ..... cubic yards	26,173
Cost per cubic yard	$0.164

FLINT CREEK TO IOWA RIVER LEVEE.

Under contract with John A. O'Keefe & Co., and McDonnell & Kennedy, and under agreements with John A. O'Keefe & Co., and Cameron, McManus & Joyce, levee construction was performed on sections 9, 11, 12, 13, 16, 17, 18, 23, 33, and 34, and 262,932.8 cubic yards of earthwork were put in place during 1897. Sections 9, 11, 12, 13, 16, 17, and 18 were completed according to specifications, and a large amount of work was performed on sections 23, 33, and 34.

Levee construction was performed during parts of all but two months of the year. During the month of February construction was suspended on account of severe cold weather, and during the month of April construction work was suspended on account of high water. Considerable damage was caused to the levee during the high water in April. This damage was repaired by hired labor during October and November, under agreement with Victor Swafford.

During the month of November, 1897, 9 lines of 36-inch drainage pipe, aggregating 648 linear feet, were put in place at Running Slough, section 27; Laswell Slough, section 30, and Campbells Lake, section 33. Two lines were fitted with iron valves and 7 lines with wooden valves. Two lines of pipe for Tama Slough, section 35, with valves, are on the bank at Oquawka. The iron pipe was purchased at the very low price of $16 per ton, delivered at Oquawka. Retaining walls containing 28.84 cubic yards coursed rubble masonry were constructed at Gates Lake, Cox Lake, and Campbells Lake, and construction of large wall at Laswell Slough was begun.

During January, February, March, May, and June, 1897, 2,704 linear feet of shore protection were constructed along the right bank of the Iowa River by hired labor, at a cost of $1.99 per foot. Twenty-two hundred and forty-two cubic yards of rock and 1,063.06 cubic yards of brush were put in this shore protection.

In February 1,280 linear feet of revetment were constructed at Iowa Slough, section 16, for the preservation of the levee, in which work 400 cubic yards of rock and 552.6 cubic yards of brush were used. This work was performed by hired labor.

In March grass seed was sown on about 8 miles of levee embankment, for its preservation.

In November, 1897, U. S. towboat *Vixen* delivered 1,624.5 cubic yards riprap rock at Crutchfield Prairie, and 477.1 cubic yards above Huron Slough. It is proposed to use this rock in protecting the levee slope at these very exposed points.

The work pertaining to this levee has been in charge of Mr. E. E. Barrett, inspector, since its commencement, and his duties have been well performed.

Statement of expenditures, 1897.

Drainage	$2,687.72
Superintendence, engineering, and contingencies	6,717.25
Repair and maintenance	407.71
Iowa River shore protection	4,348.91
Revetment	2,492.14
Surveys	145.17
Earthwork	*28,011.32
Total	44,810.22
Average cost per cubic yard of earthwork, including superintendence, engineering, and contingencies	.132
Average cost per cubic yard for superintendence, engineering, and contingencies	.026

* Includes December estimates paid in January, 1898, and retained percentage.

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Statement of expenditures from commencement of work to December 31, 1897.

Surveys for final location, etc	$5,228.54
Right of way	38.25
Drainage	5,737.98
Superintendence, engineering, and contingencies	18,119.88
Repair and maintenance	534.87
Revetment	2,492.14
Iowa River shore protection	5,387.28
Earthwork	96,787.88
Total	134,326.82

Average cost per cubic yard earthwork, including superintendence, engineering, and contingencies ..... .119
Average cost per cubic yard for engineering and contingencies ..... .019

The prices paid for earthwork during 1897 were as follows: John A. O'Keefe & Co., sections 9 to 18, $10\frac{33}{100}$ cents; Kennedy & McDonnell, sections 23 to 27, $8\frac{88}{100}$ cents, and sections 28 to 32, $10\frac{74}{100}$ cents; Cameron, McManus & Joyce, section 33, $11\frac{1}{4}$ cents; John A. O'Keefe & Co., section 34, $10\frac{8}{10}$ cents.

SURVEYS.

Under instructions of Lieutenant Keller, I organized a survey party, which was put in charge of Mr. B. P. Garrett, surveyor. The intention was to make a sufficiently accurate hydrographic survey from Lagrange to the mouth of the Missouri River, and this intention was carried out. The party took the field August 8 and completed the work November 23, 1897, covering 155 miles of river. Incidental to the survey there were established 132 permanent points; 202.8 miles of transit lines and 124 miles of stadia lines were run, and 80,104 soundings were taken. The survey notes are now being platted in the office at Rock Island.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 1, 1898.

COLONEL: I have the honor to submit the following report of improvement work performed under my charge between Keithsburg and Quincy, Ill., for the calendar year 1897:

KEITHSBURG TO NASHVILLE.

Dams and shore protections (hired labor).—This work was in charge of Mr. John R. Carpenter, overseer, and was mostly carried on above Burlington, necessitating a long tow for both brush and rock. More than half of the latter came from Appanoose and had to be towed 25 to 35 miles upstream, requiring an additional expenditure for fuel. So much of the work was shore protection that the proportion of brush is smaller than it would be had there been more dams to build, making the expense per cubic yard larger. From Mr. Carpenter's report I quote the following:

"Work was carried on in this district from June 15 to July 14, and from August 15 to November 16, 1897. The work was done by hired labor and use of Government plant. Steamer *Vixen* was employed in towing material. On June 15 the fleet was taken to Dallas and work of building Dams 8 and 21 (sheet 60) commenced. Dam 8 is 800 feet long and built to a 4-foot stage; Dam 21 is 1,600 feet long and built to a 4-foot stage. This work was finished on July 14 and the fleet employed below Keokuk until August 15, when the work was resumed in this district, protecting the bank below Oquawka, building Dam 1 (sheet 57), and protecting towhead opposite Oquawka. Dam 1 is 425 feet long, and the shore protection below Oquawka is 6,630 feet long. This work was finished September 21 and the fleet moved down to Henderson River, where the bank on the Illinois side was protected for a distance of 3,320 feet and Dams 13, 14, 15, and 16 (sheet 58) were built; 1,325 linear feet of shore protection were constructed on sand bar at head of Island 373; 3,042 linear feet on Island 373, and 1,130 linear feet on sand bar at foot of Island 375. This work

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being finished, the fleet was moved down river and light repairs made to shore protection at different places on Islands 377, 384, 386, and 395. These repairs were finished on November 16, the laboring force paid off, and the fleet taken into the canal and laid up for the winter."

List of works constructed and repaired and material used during season of 1897, between Keithsburg and Nashville.

[Hired labor.]

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 57:	*Feet.*	*Feet.*	*Cub. yards.*	*Cub. yards.*
Shore protection below Oquawka	6,630	10	9,602.3	7,142.4
Dam 1, and shore protection on towhead	425	4–1	838.4	1,171.4
Sheet 58:				
Dam 1, repaired			108.1	
Dam 13	700	4	973.6	2,310.5
Dam 14	605	4	1,040.4	1,773.5
Dam 15	486	4	931.5	2,520.5
Dam 16 and wing (600 feet)	1,230	1	874.7	4,160.3
Shore protection, Henderson River	3,320	8	3,520.3	3,265.7
Shore protection on sand bar at head of Island 373	1,325	5	832.7	1,368.5
Shore protection, Island 373	3,042	8	3,239.9	3,266.8
Shore protection on sand bar, foot of Island 375	1,130	5	1,101.5	929.3
Sheet 59:				
Shore protection, Island 377, repaired			168.1	
Sheet 60:				
Dam 8	800	4	877.8	3,411.4
Dam 21	1,600	4	1,334.9	2,416.9
Shore protection, Island 384, repaired			169.2	
Shore protection, Island 386, repaired			254.4	
Sheet 62:				
Shore protection, Island 395, repaired			184	
Total			26,051.8	32,737.2

Financial statement for work of building dams and shore protection between Keithsburg and Nashville during season of 1897.

[Hired labor.]

Amount expended in field during calendar year 1897 (from distribution sheets)	$32,309.85
Add quota of general superintendence and office expenses	1,027.46
Add for use and deterioration of plant	2,877.14
Total	36,214.45
Deduct cost of dredging at Dallas	1,091.05
	35,123.40
Material put in works:	
Rock, cubic yards	26,051.8
Brush, do	32,737.2
Total, do	58,789.0
Average cost per cubic yard:	
On barges	0.366
For towing and putting in place	.165
For general superintendence and office expenses	.017
For plant	.049
Average cost per cubic yard in place	.597

Dam and shore protections (contract).—Albert Kirchner, contractor, began this work on July 12, 1897, Mr. C. H. Sisson being inspector. Owing to high water prevailing at the time, the brush and rock apron was put in before grading the bank, and as a consequence there was a difficulty, after the water receded, in getting the bank flat

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enough, and the shore protection is not as smooth a piece of work as could have been done under more favorable circumstances. Eight thousand and four feet of bank was protected in the usual manner, extending from head of Crutchfield Prairie, on the Iowa side, to the point above Oquawka. Below the point on the Iowa side three dams, 4, 5, and 6 (sheet 56), were built to concentrate the river into one channel where it was previously divided into several, and to force it over to the Illinois shore above Oquawka. One closing dam (No. 2, sheet 57) was built to a 1-foot stage below low water only, to prevent the escape of too much water from the main channel past Oquawka. One thousand two hundred and seventy feet of shore protection was built on Illinois shore opposite Island 360, and repairs made to shore protection on west end of Dam 18 (sheet 55). The contract was finished September 24 and the fleet withdrawn.

List of works constructed and repaired and material used during season of 1897 between Keithsburg and Nashville.

[By contract.]

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 55:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 18, repairs	.....	.....	301.8	.....
Shore protection, Illinois shore, opposite Island 360	1,270	.....	1,822.7	1,831.4
Sheet 56:				
Shore protection above Oquawka, on Iowa shore	8,004	.....	13,233.1	8,790.3
Wing dam 4	1,180	4	2,090.9	2,482.3
Wing dam 5	1,480	4	3,189.9	4,289.5
Wing dam 6	1,960	3	4,759.9	8,456.8
Sheet 57:				
Closing dam 2	1,150	(a)	2,154.6	2,697.6
Shore protection on towhead above Island 365	260	.....	489.7	394.9
Total	.....	.....	28,042.6	28,942.8

a Low dam.

Financial statement for work between Keithsburg and Nashville, performed under contract with Albert Kirchner in 1897.

Amount paid contractor		$33,541.73
Cost of local inspection, etc		735.03
Add quota of general superintendence and office expenses		1,090.93
Add plant charge		28.68
Total		35,396.37
Material put in works:		
Rock	cubic yards	28,042.6
Brush	do	28,942.8
Total	do	56,985.4
Average cost per cubic yard in place		$0.621

Dredging sand at foot of Dallas Chute.—A channel 100 feet wide and 800 feet long was dug along the bar at the foot of Polk Island (No. 386). U. S. dredge *Phœnix* and tender *Louise* with double crew worked from June 15 to June 30, when the outfit was taken to Burlington for work in Burlington Harbor. The effect of this dredging was to keep the navigation open until the effect of the dams built opposite and below could be had. Later in the season this temporary channel was abandoned, as the water cut a new channel much straighter and deeper past the ends of Dams 8 and 21 (sheet 60), which was preferred by most boats. Cubic yards moved, 11,935.

Dredging Burlington Harbor.—Under an allotment of $5,000 for dredging the harbor at Burlington, contained in the river and harbor act of September 19, 1890, there remained a balance of $3,094.38 available for keeping the river front clear of deposit. Owing to the slack current at Burlington and the washing off of rafts above and below the packet landing and unloading of sand from barges, the harbor had become considerably filled up since the last work was done there in 1890. The *Phœnix* and tender *Louise* were sent there July 1, 1897, and in a few days gave the relief neces-

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sary. Eight thousand seven hundred and ninety-nine cubic yards of sand were removed.

Removing rocks at Fort Madison.—On June 12 drill boat No. 6, on her way to Rock Island, began work drilling and blasting the high point of rocks on the lower end of a reef about mid-channel, opposite the Fort Madison steamboat landing. This lower end had not more than 2 feet on it at low water and had damaged many boats. It was thought sufficient for the present to blow off the highest point of these rocks, there being 3 feet and more on the rest of the patch. On June 16 the drill boat had completed her work and was towed to Rock Island. This work was paid for from the appropriation for "Operating snag boats and dredge boats on Upper Mississippi River."

Buoys.—Under your instructions a large number of buoys were put out after the low-water season began, to assist navigation at particularly difficult places. Some were put out by the steamer *General Barnard* and others by the canal launch *Lucia*. The buoys were of white cedar, 15 to 20 feet long, and shackled to heavy stone anchors. It was found that the continuous sawing and working of the buoy was disastrous to the fastenings, which in some instances were worn to a mere thread and in others cut through, allowing the buoy to escape. Irons five-eighths inch thick in some cases did not last over a month. No doubt a few of the buoys were scraped off by rafts, and a few dragged their anchors into deep water and sank.

KEOKUK TO QUINCY.

There was but little work done in this district during the past season beyond dredging and blasting rock at Gregory Landing and Keokuk and finishing a piece of shore protection on the Illinois shore at Bludsoes Crossing. A break in the Warsaw-Quincy levee was repaired by purchase of material in open market.

In March, 1897, a season of high water set in, culminating at a stage of 18.5 on April 27, that did some damage by overflow and caused considerable changes in the channel of the river. Most of these changes when in the vicinity of our works were for the better, scouring out and deepening the desired channel. In a few cases, however, the downward movement of the bars, due to the high water, has resulted in an awkward condition of the channel, though in no case is there a deficiency in depth.

Above the Quincy Bridge a bar of long standing has moved down so far that boats, after crossing the bar, are obliged to make a square crossing of the river from the Illinois to the Missouri side, and only a short distance above the bridge. This has been a difficult maneuver to execute, especially with rafts, though no accidents have been reported. A good survey of this crossing and above it was made by Mr. Garrett in August, 1897. It will be necessary to take radical measures at this place when navigation opens next year, as the bar is moving down directly on the draw of the bridge, and is dry in places at a 2-foot stage.

An important change of channel occurred 2 miles below Gregory, the water leaving the Iowa side west of Island 409 and taking its old course east of the island along the Illinois shore. This change has long been anticipated, and is in line with the approved project for improving the river.

During the whole season there has been no less than 4½ feet for navigation, and boats have had no difficulty when they kept in the channel.

Dams and shore protections (hired labor).—This work has been in charge of Mr. Carpenter, from whose report I quote as follows:

"On July 14 the fleet was transferred from Keithsburg to Nashville to this district, and work commenced raising old shore protection between Upper and Lower Bludsoes from a 5-foot to a 10-foot stage; 5,866 feet was completed, and 1,730 feet of shore on Island 407 protected to an 8-foot stage. On August 14, having closed up Thompson & Gray's contract that was outstanding from 1896, work was suspended and fleet transferred from Keithsburg to Nashville."

List of works constructed and repaired and material used during the season of 1897 between Keokuk and Quincy.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 63:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Shore protection, Island 407	1,730	8	2,192.5	1,646.5
Sheet 64:				
Raising shore protection at Bludsoes from 5 to 10 feet	5,866	10	4,114.1	.....
Total	.....	.....	6,306.6	1,646.5

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Financial statement for building dams and shore protection between Keokuk and Quincy during season of 1897.

[Hired labor.]

Amount expended during calendar year 1897 (from distribution sheets)	$5,896.68
Add quota for general superintendence and office expenses	187.52
Add for use and deterioration of plant	621.82
Total	6,706.02
Materials put in place:	
Rock, cubic yards	6,306.6
Brush, do	1,646.5
Total, do	7,953.1
Cost per cubic yard:	
On barge	$0.432
Towing and putting in	.310
Superintendence and office expenses	.023
Plant charges	.078
Average cost per cubic yard in place	.843

Removing rock at Keokuk and Gregory.—This work was performed by drill boat No. 6 and dredge *Phœnix*, assisted at various times by the towboats *Mac*, *Louise*, and *Vixen*. Drill boat No. 6 was towed from Rock Island Rapids on April 14, and worked from April 14 to May 17 on the patch above Gregory, Mo., which was found to be of a soft formation easily drilled and broken. While there an interruption of fourteen days, from April 21 to May 4, occurred, owing to the extreme high water, and the crew of the drill boat and towboat *Mac* were employed protecting the Warsaw-Quincy levee in exposed places by use of sacks and brush, and in which they performed excellent service under Mr. J. E. Higgins, overseer. On May 17 the fleet moved to Keokuk to the patch opposite the Standard Oil Company's warehouse at Keokuk, and worked there from May 17 to June 12, when it was towed to Fort Madison. The ledge at Keokuk proved to be particularly hard and compact limestone, which broke up in large blocks often too large for the dredge to handle. It is supposed that the lack of waterproof covering for the rack-a-rock cartridges was one cause of the ineffectual shattering of the rock. This fault I understand has since been recognized and cured in work on the Rock Island Rapids. As the drilling proceeded, a much larger area was found to require removal than was originally designed, and in November (from November 7 to November 11) drill boat No. 6 was recalled from the Rock Island Rapids and spent five days in redrilling some high points that resisted the best efforts of the dredge.

Dredge *Phœnix* and tender worked on these two patches as follows, under Mr. Carpenter and Mr. Layton; both works were finished and resulted in greatly improved navigation: *Phœnix* and *Vixen*, at Gregory, from June 1 to June 14; *Phœnix* and *Louise*, at Gregory, from November 2 to November 11; *Phœnix* and *Louise*, at Keokuk, from September 1 to November 1.

Keokuk.

Holes drilled	672
Holes blasted	653
Pounds rack-a-rock used	2,199
Solid cubic yards blasted	644
Square feet of area blasted	10,752
Cubic yards of rock dredged	2,906
Cost of dredging	$2,894.12
Cost per cubic yard of dredging	$0.999

Gregory.

Holes drilled	347
Holes blasted	319
Pounds rack-a-rock used	841
Solid cubic yards blasted	250
Square feet of area blasted	5,044
Cubic yards of rock and sand dredged	4,015
Cost of dredging	$1,723.38
Cost per cubic yard of dredging	$0.429

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The rock excavated at Gregory and Keokuk was paid for from appropriation for "Operating snag boats and dredge boats on Upper Mississippi River."

Buoys.—Under your direction several buoys were put out for assisting navigation at the shoal places. These buoys are of great benefit, especially at night, and should be painted so as to offer the best chance of finding them at night when illuminated by the search light carried by all boats.

ENLARGEMENT AND REPAIR OF WARSAW-QUINCY LEVEE.

The high water of 1897 culminated in a stage of 18.5 feet on April 27 at Keokuk. This was nearly 4 feet below the crown of the levee. On the upper district the levee commissioners took all apparently needful precautions, and had patrols every one-half mile, with a mounted messenger to every 2 miles of levee. In spite of everything done, a crevasse at Station 295+60 occurred without warning on the morning of April 27, in a portion of the levee quite unsuspected of weakness, and it soon became a roaring torrent. The broken levee was of sandy loam of a very loose nature, which, however, had shown no signs of slipping or softening, and the patrol had passed over the place that broke not over an hour before it happened. The levee at that place is on comparatively high ground, and back of the levee was an extensive wheat field. By April 30 the crevasse was 300 feet wide and constantly increasing. The inhabitants of the Hunt and Lima Lake districts had ample warning, and escaped without any loss of life so far as could be heard from. Most of the stock also escaped, either to the levee or the bluffs. The snag boat *General Barnard* and the crew of the drill boat No. 6 were hurried to the break and lent their aid in pinning the broken ends of the levee and in lessening the damage as much as possible. Barges of rock were dragged through the overflowed woods and unloaded on the north side of the crevasse. Sacks filled with sand were also used to help out; tarpaulins weighted with rock and spread over the face of the levee under water were also tried. At the south side of the break the levee commissioners worked with sacks only, and had about as much success as was attained with rock at the other end of the break. But their task was a smaller one, as the scour and current were much less on the south of the break than on the north. In less than a week the whole of the two districts, Hunt and Lima Lake, were under water, the back flow going up to within 3 miles of Warsaw. At the lower end the lack of an opening into the river caused the water to be impounded and to rise considerably above the height of the water in the river. Under these circumstances authority was given the commissioners to cut the levee in order to let the impounded water out, and as the river fell to drain off the water and, if possible, get the ground in condition for planting a crop before it became too late. It may be said that in the greater part of the district this was accomplished, and two-thirds of a crop was raised after the water fell. The great damage done was to farm land behind the levee and the scattering of the inhabitants of the district, many of whom, having lost confidence in the levee, wandered off and never returned.

In the Indian Grave district no crevasse occurred. The commissioners sent an expert along the levee early in the spring, and had every muskrat hole hunted out, dug up, and refilled. With far less care than on the upper district, they came through the high water without a crevasse. However, there were two crevasses, at Stations 1205 and 1210, from Bear Creek on January 3, 1897, and this water entering at the upper end of the district gradually found its way to the lower end and submerged about one-half of the whole arable land protected by the Indian Grave levee. In both cases of overflow resort was had to cutting the levee at the lower end of the districts to let the water out. On both districts the drain culverts provided for letting off surface water proved entirely unable to handle such a quantity of water quickly as followed the breaking of the levee. With the exception of the crevasse at Station 295, all of the crevasses and cuts made through the levee were replaced by the commissioners of the several districts.

The crevasse at Station 295 was 450 feet long, and at the south end required a fill of 26 feet high to repair it. The material—sandy loam—seemed so insecure it was thought best to back it with a banquette of 20 feet, starting 8 feet from the crest of the levee, which is about the level of the old ground surface before the levee broke. On June 10 a contract was let, after ten days' notice, to the lowest bidder, Mr. J. C. Dwyer, of Quincy, Ill.; and as he failed to complete the work in the specified thirty working days, the cost of inspection thereafter was assessed against him, and paid by deduction from the amount of his estimate. Work began June 21 and was finished September 13. A small amount of brush-and-rock protection was placed on the front of the levee where most exposed to the current of the river. The rock for this was gained from the old end of the crevasse, where it had been dumped during high water to prevent it from getting larger.

The total amount expended for care and maintenance of this levee during the year was $9,185.93.

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QUINCY BAY.

The bulkhead at the mouth of Whipple Creek, built in 1893–94, has continued to do its work effectively, and has protected the dredged channel between the upper and lower bay very effectively. The area embraced in the bulkhead has raised very considerably, and is now overgrown with a dense thicket of willows, which will tend to increase the deposit at flood times, and will also protect the bulkhead from direct attack by the creek. Near the north end of the bulkhead the creek has taken a new course, and approaches within 15 or 20 feet of the bulkhead, and threatens to undermine it if not attended to.

I would recommend about 100 feet of brush-and-rock protection at this place, which ought to cost not over $150. No work was done on the bulkhead during the past year.

Very respectfully, your obedient servant,

M. MEIGS, *U. S. Civil Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. S. EDWARDS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1898.

COLONEL: I have the honor to submit the following report of operations for improving the Mississippi River, and protecting from erosion its bank along and in front of the Sny Island Levee, in the division in my local charge, for the calendar year ending December 31, 1897:

QUINCY TO HAMBURG.

The work of improving the Mississippi River in this section, the length of which is 74 miles, was carried on by hired labor and use of Government plant, towboat *Coal Bluff* and launch *Stella* doing the towing. All supplies and material were purchased in open market under due competition. The prices paid for material were as follows: Rock, delivered on United States barges, 44 to 52 cents per cubic yard; brush, delivered on United States barges, 15 to 19 cents per cubic yard. The work consisted in building dams and protecting cutting banks by revetment. From May 28 to June 28 a small force was employed making the necessary repairs to boats and barges, and June 28 the fleet left Quincy Bay beginning the season's operations. The following new dams were built: 9, 10, 11, 12, and 13 (sheet 68), in the vicinity of North and South rivers, 6 miles below Quincy, and Dam 14, opposite Quincy. Repairs made consisted in closing gap in Dam 1 (sheet 69). Shore protection was constructed at the following points: Orton Island, 1,450 linear feet; Fabius Island, 2,919 linear feet; head of Hickory Chute, Missouri shore, 1,775 linear feet; Island 462, 3,400 linear feet; Island 468, 3,000 linear feet; shore protection on Turtle Island was repaired. Total linear feet of dams constructed, 5,551; total linear feet of revetment work, 12,544.

The channel at North and South rivers has for years been troublesome, the crossing being almost at right angles to the direction of the banks, and the turns sharp, making it especially hard for long rafts to navigate. Owing to the enormous amount of sand to be removed, improvements at this point were postponed until such time as the river should of its own accord show some tendency to follow a straighter course. A survey made shortly before the fleet started out showed that the time for improving this point had arrived, the old crossing having become shoaler than it was last year and a straighter channel having formed, which, though very shallow, was in the desired direction. Four wing dams were built from the Missouri shore and one from the Illinois shore. At no time during the season was there any trouble here, although the moving of the sand formed new reefs almost daily. The work at this point is not completed, and the moving sand will have to be followed until it can gradually be forced in between new dams.

Dam 14 (sheet 68) is located on the Missouri shore opposite the city of Quincy, pointing toward the steamboat landing, and was built to a 6-foot stage. As this dam was completed just as the season closed no comment on its effect can as yet be made, but it is expected that it will give much relief to the crooked channel now leading up to the steamboat landing. During the season of 1896 Dam 1 (sheet 68), located 1,450 feet above Dam 14, was extended 363 feet, elevation 8 feet below low water of 1864. I am pleased to say that its work has been successful, having cut off 800 feet from the point of the bar below it, filled in where it was desirable, and cut out the shallow portions of the legitimate channel.

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In protecting banks the ones most exposed were selected, and the elevation of the top of revetment is such that it covers effectually the sandy strata. An apron 40 feet wide was laid at the foot of the bank, sunk with stone, and the protection carried up on the bank in the usual manner.

The channel was in fair condition all season, and no boats were reported to me as having been aground. At the close of the season a trip was made for the purpose of sounding all crossings, with the following result on the shallowest places, viz (gauges at Quincy, 2.6; at Hannibal, 2.5; at Louisiana, 1.3): Bend below Quincy, 8 feet; Orton Island, 10 feet; North River, 6 feet; Marion City, 8 feet; Upper Whitney, 8 feet; Lower Whitney, 4.5 feet; Turtle Island, 8 feet; Cave Hollow (lower), 5 feet; Saverton, 6 feet; below Cincinnati Landing, 4.5 feet; Mundys, 5.5 and 7 feet; head of Hickory Chute, 6 feet; foot of Hickory Chute, 5.5 feet; above Louisiana, 5.5 feet; Kreiders Bend, 8 feet; Island 460, 7 and 8 feet; Clarksville, 6 feet; below Clarksville, 8 feet; Eagle Island, 5 feet; opposite Carroll Island, 5 feet; Coon Island, 8 feet; Grimes Island, 6 feet; head of Tildens Island, 5.5 feet; foot of Tildens Island, 5.5 feet; head of Thomas Chute, 4.5 feet.

As will be seen the shallowest places were found at Lower Whitney, below Cincinnati Landing, and at the head of Thomas Chute. Cave Hollow, below Hannibal, with 5 feet, caused some delays with heavily loaded barges. Unless some changes occur before next spring the above four places should be attended to, work to begin, perhaps, at Thomas Chute. A survey was made early in the season from Amaranth Island to Grimes Island and plotted in the field. This showed this portion of the river to be in better condition than it was last fall and did not call for immediate improvements, which accounts for the difference in work performed and project submitted before starting out.

List of works constructed and repaired and of material used on "General Improvement," Quincy to Hamburg, during season of 1897.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 68:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam 9	400	4.5	498.2	1,463.9
Wing dam 10	450	4.5	728.4	2,265.3
Wing dam 11	880	4.5	590.3	1,653.1
Wing dam 12	240	4.5	341.7	1,311.6
Wing dam 13	2,300	4.5	4,057.4	11,815.2
Wing dam 14	1,781	6	2,000.6	5,151.4
Shore protection, Orton Island (429), extended	1,450	(a)	1,037.6	3,268.4
Shore protection, Fabius Island (431)	2,919	(b)	3,043.7	5,858.7
Sheet 69:				
Closing dam 1, repaired	.....	.....	632.6	458.7
Sheet 70:				
Shore protection, Turtle Island (439), repaired	.....	.....	190.4	.....
Sheet 74:				
Shore protection, Missouri shore, head of Hickory Chute, apron extended	1,775	1.5	213.3	1,651
Sheet 76:				
Shore protection, Island 462	3,400	12	4,851.5	9,750.7
Sheet 77:				
Shore protection, Island 468	3,000	11	3,784.7	7.132.5
Total	.....	.....	21,970.4	51,780.5

a 1,200 feet of this shore protection to 6 feet and 250 feet to 2 feet above low water of 1864.
b 2,044 feet of this shore protection to 12 feet and 875 feet to 8 feet above low water of 1864.

Financial statement for work of constructing dams and shore protections between Quincy and Hamburg performed by hired labor during season of 1897.

Amount expended in field during calendar year 1897 (from distribution sheets)	$34,794.76
Add quota of general superintendence and office expenses	1,100.08
Add for use and deterioration of plant	3,237.60
Total	39,132.44

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Material put in works:		
Rock	cubic yards..	21,970.4
Brush	do....	51,780.5
Total		73,750.9

Average cost per cubic yard:	
On barge	$0.266
For towing and putting in place	.206
For general superintendence and office expenses	.014
For plant	.044
Average cost per cubic yard in place	.530

SNY ISLAND LEVEE.

The river and harbor act of June 3, 1896, contains an allotment of $50,000, or so much thereof as may be necessary, in the opinion of the Secretary of War, for the protection from erosion of the east bank of the Mississippi River along and in front of the Sny Island Levee, in the counties of Adams, Pike, and Calhoun, in the State of Illinois, for the maintenance of the channel of the river by revetment work or otherwise.

During the fiscal year ending June 30, 1897, there was expended on the above work $10,528.69; the amount expended to December 31, 1897, is $36,950.18, leaving available $13,049.82.

The work consisted in building shore protection and dams, such places being selected where the work would equally benefit the levee and the channel of the river.

Two dams were built in the vicinity of Saverton, viz, Dams 5 and 6 (sheet 72). Dam 5 is a closing dam between the Illinois shore and Cottel Island (446); Dam 6 is a wing dam, a short distance above the island. The levee at this point is quite close to the river bank, and the dams will divert the current from the levee, while at the same time they will improve the channel at this point. Another dam (No. 16, sheet 74), built from a point below Island 452 and running toward the head of North Fritz Island, not only greatly improved the channel there, but will tend to fill up the slough to the east of North Fritz Island, and thus prevent any cutting of the bank in front of the levee for a distance of 4 miles or more. At Cincinnati Landing the levee is quite close to the river, and here 6,875 linear feet of bank was protected in the usual manner.

The dams built measured 4,702 linear feet, elevation 4.5 feet above low water of 1864; the shore protection measured 6,875 linear feet, elevation 5 to 10 feet above low water of 1864.

The fleet was laid up in Quincy Bay on November 21, with the exception of towboat *Coal Bluff*, which was taken to the Des Moines Rapids Canal, being unseaworthy for another season's work without extensive repairs.

List of works constructed and of materials used on Sny Island Levee during season of 1897.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 72:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 5	800	4.5	1,223.6	3,229
Wing dam 6	1,750	4.5	3,165.8	10,272
Sheet 73:				
Shore protection, Cincinnati Landing	6,875	(a)	7,562.9	11,518.6
Sheet 74:				
Wing dam 16	2,152	4.5	6,899.1	15,966.4
Total			18,851.4	40,986

a 4,275 feet of this shore protection to 10 feet and 2,600 feet to 5 feet above low water of 1864.

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Financial statement for work of protecting Smy Island Levee, performed by hired labor during season of 1897.

Amount expended in field during calandar year 1897 (from distribution sheets)		$26,770.81
Add for use and deterioration of plant		1,609.54
Total		28,380.35
Material put in work:		
Rock	cubic yards	18,851.4
Brush	do	40,986.0
Total	do	59,837.4
Average cost per cubic yard:		
On barges		$0.272
For towing and putting in place		.174
For plant		.027
Average cost per cubic yard in place		.743

REMOVING SAND BAR AT QUINCY STEAMBOAT LANDING, QUINCY, ILL.

No field work was performed on the above allotment, it being thought best to await the result of work performed and to be performed on general improvement, which may remove much of the bar, and then expend the available balance, $4,902.57, in dredging. The cuts made through the bar last season did not prove a success, the continued high water this spring filling them again, but the extension of Dam 1 (sheet 68) was successful beyond expectations, having cut away 800 feet of the lower point of the bar, deepening the water about 4 feet.

WILLOW PLANTING.

With a view of ascertaining the best way of planting willows so as to start vegetation on bars, if desired, I, by your authority, made the following experiment in fall of 1896: One hundred and fifty fascines of 5 to 10 willows each were laid in trenches 2 to 3 feet deep, butt end down and the tips slightly out of the ground. This fall every one showed sprouts. One hundred and fifty facines, same as above, were buried tips down, butt end up. All of these died. One hundred and fifty young willows with roots were planted upright and roots surrounded with black earth, planted in as near the same way as originally found. Of these, 9 showed growth. One hundred and fifty willows from 6 to 20 feet long, cut off at the ground, were planted by simply sticking them into the bar, half of them surrounded with black earth and willows leaning slightly down stream. Every one of these died.

After further investigation I have come to the conclusion that the time for planting them was poorly chosen, and that they should have been planted in the spring. The experiment would perhaps have been more successful but for an unusual continued high water. I would add that all cottonwoods and maples planted died. The raising of willows is an important question, it being of the utmost importance to very often start vegetation on bars and thus keep them in place. Willows are also gradually becoming harder to obtain, and the demand for them is increasing.

I would respectfully suggest that further experiments be made, and that next spring be chosen to do this. As an acre can be planted for about $6, the experiment could be made on a large scale at small expense.

PURCHASE OF MATERIAL.

I would respectfully call your attention to the method of purchasing material. Of late years this has been done by bids and informal contracts. This method may perhaps bring down the cost of material somewhat, but it opens the market to unreliable bidders, who have no idea of living up to their contracts and whose failure to do so causes much delay to the work. If contracts could be let during the winter, provisionally on the passage of an appropriation bill, and bidders put under bond, I

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am sure the material would be as cheap and no delays occur after the field work had begun. I have assurance that contractors would be glad to bid as above, which will enable them, during the winter, to employ their men, the men being glad to accept work at a less rate per day.

In conclusion I wish to extend my thanks to B. J. Metzger, master and pilot; Ed. H. Jones, receiver of material, and F. M. Haverstick, subinspector, for their faithful and efficient services.

Respectfully submitted.

S. EDWARDS, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF FIRST LIEUT. CHARLES KELLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1898.

COLONEL: I have the honor to submit the following report of Mississippi River improvement work performed between Hamburg, Ill., and the mouth of the Missouri River during the calendar year ending December 31, 1897:

HAMBURG TO ILLINOIS RIVER.

Improvement of the river between above-mentioned points was provided for under an allotment of $50,000 from appropriation of act of June 3, 1896. The work was to be done by contract in accordance with project approved September 4, 1896. Under date of December 14, 1896, a contract was entered into with Mr. Albert Kirchner for the construction of dams and shore protections in accordance with above project and allotment. The prices to be paid were $1 per cubic yard for rock and 30 cents per cubic yard for brush, in place.

The contractor having all his plant engaged upon similar work at other localities on the river was not able to begin work under this contract until September 25, 1897. Operations were commenced above Turners Island. The unfavorable condition of the channel at this point caused considerable complaint from steamboat men. The river is very wide and flat here and the channel is divided and cut up into numerous branches. To cut off these branches and confine the river to desired width it was decided to construct the following works: 3 closing dams (7, 8, and 9, sheet 80) on Missouri side of river opposite Turners Landing; a trailing dam (No. 12) extending from Turners Landing on Illinois shore to the towhead opposite head of Turners Island, and 3 transverse dams (10, 11, and 13), extending from the Illinois shore to and connecting with the above-mentioned trailing dam. All these were completed during the season, as projected, except the trailing dam. Work on it was suspended November 30, 1897, to be resumed next season.

Although the trailing dam was unfinished at end of season a material improvement was noticeable in the channel at the close of navigation.

The bank was found to be cutting on the Missouri shore at foot of Sterling Island. Protection of this bank being necessary, the work was commenced, but could not be completed before season closed. The shore was protected for a length of 2,325 feet, leaving about 1,200 feet yet to be done.

This contract work was carried on under the local inspection of Mr. R. Monroe, whose service was thoroughly efficient.

The contract with Mr. Kirchner not being completed at close of season, authority was obtained for its extension until June 30, 1898.

Under an allotment of $50,000, and in accordance with project approved July 9, 1897, a contract was entered into with James Short, of St. Charles, Mo., under date of September 20, 1897, for the construction of dams and shore protections between Hamburg and mouth of Illinois River. The prices to be paid were 80 cents per cubic yard for rock, and 40 cents per cubic yard for brush, in place; the approximate quantities of material to be used are 35,000 cubic yards of rock and 55,000 cubic yards of brush.

No work was done under the above contract. The contractor having his plant engaged elsewhere it was deemed best to postpone the commencement of operations until season of 1898.

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Further details as to length and height of works constructed are given in accompanying tables and sketches:

List of works constructed and of materials used, during season of 1897, between Hamburg and Illinois River, under contract with Albert Kirchner.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 80:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 7	330	1	565	1,079.8
Closing dam 8	900	1	1,029.3	2,083.6
Closing dam 9	356	1	1,232.5	1,292.5
Transverse dam 10	600	1.5	2,557.7	3,246.4
Transverse dam 11	260	3	994.1	923.2
Trailing dam 12	3,575	3	8,296.9	18,318.1
Transverse dam 13	550	1.5	367.2	483.5
Shore protection, Sterling Island	2,325	.....	6,629.5	4,639.5
Shore protection, Turners Towhead	750	.....	1,546.9	1,141.6
Total	.....	.....	23,219.1	33,208.2

Financial statement for work between Hamburg and mouth of Illinois River, performed under contract with Albert Kirchner, during season of 1897.

Amount paid contractor	$28,841.54
Add amount of unpaid estimate	1,021.87
Add retained percentage	3,318.15
Cost of local inspection, etc	570.42
Quota of superintendence and office expenses	1,040.91
Plant charges	25.41
Total	34,818.30

Material put in works:		
Rock	cubic yards	23,219.1
Brush	do	33,208.2
Total	do	56,427.3
Average cost per cubic yard in place		$0.617

ILLINOIS RIVER TO MISSOURI RIVER.

Work on this stretch of river was carried on by hired labor and use of Government plant. The materials were secured by purchase in open market, in accordance with project approved July 9, 1897, under an allotment of $80,000. The brush was delivered at the works on Government barges and the rock was loaded on Government barges at the quarries and towed to the works by U. S. towboat *J. G. Parke.*

The work consisted of the construction of closing dams, trailing dams with their proper transverse dams, extension and construction of wing dams, the protection of caving banks, the removal of outer end of one wing dam, and the widening and deepening of the winter harbor outside of Portage Island.

While there was apparent need of additional work below the Alton Bridge in the vicinity of Maple Island, a more urgent need determined the locality of the season's work above Alton and below Portage Island, several bad places in channel having appeared which needed attention.

A departure in the method of improvement was instituted this season in this section, which consisted of the building of long trailing dams concave to the channel—an adaptation of the methods employed on the river Rhone. The works thus constructed gave evidence at close of season of having produced favorable results, as the channel was materially improved at each place where this method of improve-

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ment was employed. These trailing dams were constructed to a grade of +3.0 feet above low water at the apex and gradually sloped to a grade of +0.0, or L. W., at each end, with a traverse dam at about every 2,000 feet of their length, extending from the convex side of the trailing dam to the main shore.

Trailing dams as above described were constructed at the following places: At Riverside Park, at Hop Hollow, opposite Search Island, and between Portage Island and Eagle Nest Island.

At Riverside Park the dam extends from the lower end of the shore protection downstream in a curve concave to the channel for a length of 5,000 feet, with corresponding transverse Dams Nos. 43 and 44 (sheet 74). The trailing dam at Hop Hollow is of similar construction and extends from a point on the Illinois shore about 6,000 feet below foot of Piasa Island downstream a distance of 5,700 feet and past the ends of Dams Nos. 17 and 18.

At Piasa Island the trailer extends from the outer end of Dam 5 down past the outer ends of Dams 27 and 4, ending at the outer end of Dam 23. Dams 5, 27, 4, and 23 act as the transverse dams. This trailing dam is 5,800 feet in length. The outer end of Dam 27 had to be removed in order that the trailer might be constructed so as to conform to the desired degree of curvature.

At Portage Island a trailing dam (No. 51) was commenced and extended down stream to Eagle Nest Island, a distance of 10,700 feet. The transverse dams for this trailer are Nos. 48, 49, and 50. By the construction of this trailing dam the steamboat-landing at Portage des Sioux, Mo., was cut off from river traffic during periods of low water. As this landing is one of considerable importance, it was decided to raise Dam 48 to a stage of 8 feet above low water, widen its crest to 12 feet, and construct a wide T on the outer end. The transverse dams 49 and 50, connecting with Dam 51, are built only to grade of trailing dam.

Dams 13 and 14 were extended 550 feet and 650 feet, respectively. These extensions are submerged at low water, and were made in order to further contract the channel at this point and also to prevent further scour.

A closing dam (No. 47) was constructed from the Missouri shore to Eagle Nest Island to increase the flow of water and deepen channel on Illinois side of the island.

Owing to the fact that the direction of the current at Riverside Park is almost perpendicular to the shore line, it became necessary to extend the shore protection at that point a length of 450 feet upstream.

For securing a safer winter harbor for the Government plant used in this district, it was decided to dredge out and enlarge an existing cut or bend in Portage Island, on the Illinois side of the island. This dredging was begun last year, but owing to the lateness of the season it was not completed. Work on this harbor was resumed in July, the dredging being done by U. S. dredge *Phœnix*. The dredging was completed in September, and the necessary protection work at upper end of harbor was accomplished at close of season. This harbor has a length of 1,200 feet, a width of 100 feet, and a depth of 7 feet at low water. It is convenient and safe, being well protected from wind, ice, and high water by high timbered banks and is of ample size to accommodate all the fleet of this division.

Before laying out any work this season surveys were made in the immediate vicinity of the proposed improvement in order to obtain information as to the exact condition of the river at these places. These surveys at close of season made a continuous map from Portage Island to Alton, Ill. Proposed work was laid out on these maps, and soundings were taken along the line of the proposed dams; these soundings were platted on profile paper and estimates made as to the amount of material necessary to construct the dams. In all cases the estimates approximated closely to the material actually used in the construction. Soundings were made and platted and estimates made again during progress of the construction of the dams.

In general.—The channel is in a better condition from Grafton to the Missouri River than it has been for years past, there being now no less than 4.5 feet depth at low water on any of the crossings. The present working season extended from June 16 to November 18. The towing was done by U. S. S. *J. G. Parke*. United States barges, quarter boats, office boats, etc., were also used in their respective places in carrying on the work.

Further details as to character and extent of work done are shown in maps submitted and in the appended tables.

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List of works constructed and repaired and of materials used during season of 1897, between Illinois River and Missouri River.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Brush.
Sheet 84:	*Feet.*	*Feet.*	*Cubic yds.*	*Cubic yds.*
Wing dam 13, extended	550	(a)	623.6	738.4
Wing dam 14, extended	650	(a)	620.5	957.9
Trailing dam 42	5,700	0 to 3	7,089.9	16,181.4
Transverse dam 43	900	3	824.2	859.1
Transverse dam 44	350	1	485	807.1
Trailing dam 45	5,000	0 to 3	4,295.2	9,324.6
Trailing dam 46	5,800	0 to 3	6,177	12,051.1
Closing dam 47	1,750	0	1,700.1	4,178.8
Transverse dam 48	1,350	8	6,381	12,233.5
Transverse dam 49	1,250	2	739.6	1,966.2
Transverse dam 50	440	2	429.4	796.7
Trailing dam 51	10,700	0 to 3	18,806.6	51,154.7
Shore protection at Riverside Park, extended	450	.....	848.4	594.9
Protection of harbor at Portage Island	.....	.....	143.7	895.6
Total	.....	.....	49,164.2	112,740

a Submerged.

Financial statement for work of constructing dams and shore protections between Illinois River and Missouri River, performed by hired labor, during season of 1897.

Amount expended in field during calendar year 1897 (from distribution sheets)	$70,606.54
Add quota of general superintendence and office expenses	2,235.27
Plant charge	6,135.97
Total	78,977.78
Material put in works:	
Rock, cubic yards	49,164.2
Brush, do	112,740.0
Total, do	161,904.2
Average cost per cubic yard:	
On barges	$0.285
For towing and putting in place	.151
For general superintendence and office expenses	.014
For plant	.038
Average cost per cubic yard, in place	.488

Throughout the season the work was in local charge of Mr. A. L. Richards, United States Assistant Engineer, to whom the credit for the notable reduction in cost is almost wholly due. He was at all times ably seconded by Mr. H. J. Rossiter, United States overseer.

During the coming season attention will be directed to the effort to determine a formula for the proper curvature of the dams herein described. It is believed that observation of the dams already built, and of the curvature of the banks in stable reaches, will furnish the information desired.

Very respectfully, your obedient servant,

CHARLES KELLER,
First Lieut., Corps of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON PLANT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., February 1, 1898.

COLONEL: I have the honor to present the following report on the floating stock or plant belonging to the improvement of the Mississippi River between the mouth of the Missouri River and Minneapolis for the calendar year ending December 31, 1897.

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In this report "good" is in fine condition, wanting slight repairs or none; "fair" requires extensive repairs, or such as are advisable; "bad" should be condemned or rebuilt. Pieces condemned are omitted.

The plant in question is as follows: One large towboat (*Coal Bluff*), bad; 1 medium-sized towboat (*Vixen*), good; 2 medium-sized towboats (*Fury* and *Alert*), bad; 1 small towboat (*Ruth*), good; 1 small towboat (*Mac*), fair; 5 steam launches (*Emily, Ada, Lucia, Louise, Iris*), good; 1 steam launch (*Elsie*), fair; 1 small steam launch (*Florence*), good; 1 small naphtha launch (*Myra*), good; 2 small naphtha launches (*Dart* and *Edith*), fair; 2 dredges (*Phœnix* and *Vulcan*), fair; 4 dumps, good; 2 dumps, fair; 1 dump, bad; 2 steam-drill boats, good; 1 steam-drill boat, fair; 1 suction dredge, good; 1 pile driver, good; 2 pile drivers, fair; 1 pile driver, bad; 6 large quarter boats, good; 2 large quarter boats, fair; 2 large quarter boats, bad; 7 small quarter boats, good; 6 small quarter boats, fair; 2 small quarter boats, bad; 3 large office boats, good; 6 small office boats, good; 8 small office boats, fair; 10 grasshoppers, good; 1 grasshopper, fair; 1 derrick boat, fair; 2 store boats, bad; 1 boathouse, good; 4 building boats, good; 3 building boats, fair; 6 large model barges, fair; 43 large barges, good; 40 large barges, fair; 8 large barges, bad; 7 small barges, good; 2 small barges, fair; and a large number of skiffs, loading boats, powder boats, and pontoons in good condition. To the snag-boat service belong the side-wheel steamer *General Barnard*, fair, and stern-wheel steamer *J. G. Parke*, fair. The Des Moines Rapids Canal has a small plant, consisting of 1 steam launch (*Stella*), good; 1 dredge (*Ajax*), fair; 1 dump, good; 1 dump, fair; 1 dump, bad; 1 large barge, good; 3 small barges, fair; 1 small barge, bad.

During the year, under proper authorities, 1 large office boat and 1 barge were built at Fountain City.

Considerable repairs were made to towboats *Alert, Coal Bluff*, and *Mac;* to launches *Ada, Elsie*, and *Emily;* to dredges *Vulcan, Ajax*, and *Phœnix;* to 2 drill boats and 1 suction dredge, and to several barges and other pieces of plant. Nominal repairs were made to many pieces.

The construction and repair work at dry dock in Des Moines Rapids Canal was done under supervision of Mr. M. Meigs, United States civil engineer; that at Fountain City under supervision of Mr. W. A. Thompson, assistant engineer.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 5, 1898.

CAPTAIN: I have the honor to present a brief preliminary report of operations between Missouri River and St. Paul during the second half of the fiscal year ending June 30, 1898, as collated from reports of assistants in local charge. Full reports are made by calendar years.

St. Paul to Lake Pepin.—In local charge of Assistant Engineer J. D. du Shane. Construction work in the building of dams and shore protections has not been resumed. Plant repairs have been completed. Hydraulic dredge No. 14 was put in commission and began pumping sand May 14 at Prescott, where a channel 160 feet wide by 300 feet long, with a depth of 5 feet below low water of 1864, was cut through a bar. The dredge was moved to Island 16 on June 6, where a cut was made 160 feet wide by about 700 feet long. Dredging was begun at the foot of Island 15 on June 23. The total quantity of sand removed is 24,775 cubic yards, which has been deposited below dams and back of islands.

Harbor at Kings Coulee, Lake Pepin.—In local charge of Assistant Engineer W. A. Thompson. Operations by hired labor and use of Government plant were resumed May 16 and continued to close of fiscal year. Fifty linear feet of pier was finished, making a total completed length of 550 linear feet, and 50 feet additional has been built to a height of from 5 to 8 feet above low water of 1864.

There were used in this work 1,701.1 cubic yards rock and 4,167.7 cubic yards brush.

Reeds Landing to Trempealeau.—In local charge of Assistant Engineer W. A. Thompson. Under contract with Fetter & Crosby, the construction of dams was carried on opposite Alma from April 14, 1898, to the end of the fiscal year, and the contract was completed. Two wing dams from Island 40, commenced in 1896, were finished. A closing dam west of Island 43 and four wings running out from Island 43 were built.

There were placed in above work 9,305.7 cubic yards rock and 21,264.6 cubic yards brush.

Minneiska to Queens Bluff.—In local charge of Assistant Engineer W. A. Thompson.

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Under contract with Fetter & Crosby, the construction of dams and shore protections was carried on in vicinity of Rollingstone Slough, above Fountain City, from June 12 to end of fiscal year. Five wing dams were built from Illinois shore below old dam 19. The old wing at head of Rollingstone was repaired and 770 feet of shore protection was built on Illinois shore opposite Island 55.

There were used in above work 2,023.8 cubic yards rock and 4,950.2 cubic yards brush.

Queens Bluff to Prairie du Chien.—In local charge of Assistant Engineer W. A. Thompson. Operations in construction of dams and shore protections by hired labor and use of Government plant were commenced June 11 and carried on to end of fiscal year in vicinity of Britts Landing and De Soto. The shore protection opposite Britts, commenced in 1897, was partly rocked for a distance of 500 feet. A closing dam was built across the little slough at the lower end of this shore protection, and the shore protection was extended below the dam about 1,200 feet. At De Soto, the closing dam across Winneshiek Slough was raised and two closing dams—one from Main street to Island 141 and the other connecting islands 141 and 142—were commenced, as also the proposed 1,200 linear feet of shore protection on west side of Island 142.

There were placed in the above work 4,227 cubic yards rock, which was furnished by the United States quarry at Britts Landing, and 10,196.5 cubic yards brush. Repairs to plant were made at Fountain City.

Dredging at Dubuque.—In local charge of Assistant Engineer J. C. McElherne. Under contract with C. H. Appleton, work was resumed March 24, 1898, with one dredge on the bar at East Dubuque. On May 4 a second dredge was put at work in the ice harbor. A total area of 344,000 square feet was covered and 114,936.8 cubic yards of material were removed, the grade being 5 feet at low water. The contract was completed June 25, 1898.

Dubuque to Le Claire.—In local charge of Assistant Engineer J. C. McElherne. Under contract with George W. Farley & Co., work was resumed May 3, 1898, in vicinity of Island 233, and was carried on to close of fiscal year. One closing dam and 1,680 linear feet of shore protection were built at this vicinity. The closing dam at Stone Slough was raised and reenforced and 900 linear feet of shore protection constructed on Island 241. At Island 283 a closing dam to Illinois shore was begun.

There were used in above work 4,713.1 cubic yards rock and 9,206.7 cubic yards brush.

Rock Island Rapids.—In local charge of Assistant Engineer J. C. McElherne. Drill boat 103 began blasting in south side of Cottonwood Chain April 1, 1898, and continued work in that locality until end of fiscal year. An area of 36,544 square feet was worked over, and about 2,057 solid cubic yards rock was broken up. Dredging was resumed April 11 and carried on to end of year at Campbells Chain, Moline Pool, and Cottonwood Chain. Eight thousand nine hundred and eighty-eight cubic yards rock and 4,322 cubic yards fire clay were removed and utilized in widening old dams 3, 6½, and 8, and in building dams 22 and 23. The buoys of the system to the number of 30 were reset late in March.

Rock Island to Keithsburg.—In local charge of Assistant Engineer C. W. Durham. Construction of dams and shore protections, under contract with Patterson Bros., was resumed April 26 and continued until end of the fiscal year. The right bank of Hershey Chute and the channel bank of the towheads below were protected for a length of 6,365 feet. In vicinity of Illinois City Landing 1,845 linear feet of shore protection was built. Some repairs were made to Wyoming Slough closing dam and to the small dams at foot of of Hershey Chute.

There were put in place in above work 14,183.6 cubic yards rock and 16,205.8 cubic yards brush.

In Rock Island Harbor 855 cubic yards broken rock was dredged and placed on heads of islands 309 and 313.

Dredging at Muscatine.—In local charge of Assistant Engineer C. W. Durham. Work of dredging and removing the deposits in Muscatine Harbor, under contract with A. J. Whitney, was resumed March 21, and the contract was completed June 28, 1898. All of the work contemplated in the project was performed, and also a small additional amount of dredging above the bridge, in Pappoose Creek, and at the waterworks crib. There is now a 6-foot depth at extreme low water along the entire city front below the bridge. The amount of dredging performed in 1898 was 63,416.9 cubic yards, and under the entire contract 89,589.9 cubic yards, the material being chiefly sand, but mixed with mud, clay, and a few bowlders.

Flint Creek to Iowa River Levee.—In local charge of Assistant Engineer C. W. Durham. Levee construction was carried on continuously from January 1 to June 30, 1898, under contract with McDonnell & Kennedy and agreements with Cameron, McManus & Joyce and John A. O'Keefe & Co. By McDonnell & Kennedy, sections 23 and 24 were built, and section 25 nearly completed, 106,174.4 cubic yards earthwork being performed. Cameron, McManus & Joyce have almost finished section 33,

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with 43,490.3 cubic yards earthwork. John A. O'Keefe & Co., who had taken section 34, built during May 205.3 cubic yards and abandoned their agreement. The remainder of their work was given to Cameron, McManus & Joyce, by whom about 3,000 cubic yards earthwork has been built in this section. During January retaining walls for the drainage pipes were constructed at Running Slough and Laswell Slough, containing 44.66 cubic yards coursed rubble masonry.

In February and March 1,745 linear feet of levee bank revetment was constructed in section 15, 1,470 feet in section 22, and 4,000 feet in section 23, in which were used 2,101.6 cubic yards riprap rock.

Twenty-six miles of this levee is now practically completed under the present project, and 9¼ miles remain, for building which contracts have been let for all but 1¼ miles.

Keithsburg to Nashville.—In local charge of United States Civil Engineer M. Meigs. A small Government plant was put at work April 15 and continued operations until June 7 between the head of Dallas Chute and Fort Madison bridge. The wing dams at and opposite Potoosuc were raised and strengthened, as also the closing dam at Polk Island. In vicinity of Appanooce, Dam C was extended to the sand bar and 965 linear feet of shore protection was built on Dutchman Island.

There were put in place in this work 6,980.7 cubic yards rock and 14,892.4 cubic yards brush.

Keokuk to Quincy.—In local charge of United States Civil Engineer M. Meigs. Contract work in construction of dams and shore protections, by Albert Kirchner, were commenced April 14 and continued until completion of contract, June 25, 1898. In vicinity of Gregory a closing dam was built from Buzzard Island to the Illinois shore, and the shore protection on that island was extended 1,800 feet. The shore protection on Missouri shore, opposite, was extended 1,340 feet, and that below Gregory was repaired. In vicinity of La Grange the shore protection on Island 419 was repaired and that on La Grange Island extended 445 feet. To improve the channel in vicinity of Cottonwood Island four wing dams were built from the Illinois shore above Quincy bridge and two from the Missouri shore above the island. The wing from the head of Cottonwood Island and the closing dam from that island to Island 423 were repaired. The protection on the Illinois shore, 2,600 feet in length, was carried up to top of the bank, as also 700 feet on Missouri shore above Quincy bridge. Opposite Hogback Island 4,500 linear feet of shore protection was carried from a 5-foot stage to top of bank and extended upstream 1,100 feet. The shore protection on Missouri shore below La Grange was protected for a distance of 1,900 feet. Short pieces of shore protection were put in at head of Hogback and La Grange islands.

There were constructed under above contract 9,355 linear feet of dams and 6,585 linear feet of shore protection; 1,550 feet of dams were raised or repaired; 8,085 feet of shore protection previously built to a low stage was carried to top of bank, and 1,000 feet of shore protection was repaired.

In the above work there were put in place 22,841.2 cubic yards rock and 40,627.1 cubic yards brush.

Dredging in Quincy Bay.—In local charge of United States Civil Engineer M. Meigs. Work was begun with Government plant, consisting of dredge *Phœnix* and towboat *Vixen*, June 2, and was carried on to end of fiscal year. An area of 278,750 square feet between Quincy Marine Ways and the old bridge was covered by the dredge and excavated to a depth of 6 feet at low water; 37,209.5 cubic yards sand and mud were removed and dumped between the wing dams from Missouri shore opposite Quincy.

Quincy to Hamburg.—In local charge of Assistant Engineer S. Edwards. A small Government plant commenced operations in vicinity of Cave Hollow, below Hannibal, on May 11, 1898, and continued work in that locality to end of fiscal year. Two wing dams from Illinois shore opposite Cave Hollow, of a combined length of 3,350 feet, were built, and a third begun.

There were placed in above work 4,540.3 cubic yards rock and 17,099.3 cubic yards brush.

Hamburg to the Illinois River.—In local charge of Assistant Engineer A. L. Richards. Under contract with Albert Kirchner, operations were resumed March 7, 1898, and his contract was completed April 9. The trailing dam from Turners Landing and one transverse dam were completed. Shore protections at Sterling Landing and at head of Stag Island were finished and shore protection on Missouri shore opposite Turners was commenced.

The above comprised a total length of 1,425 feet of dams and 6,075 feet of shore protection, and there were used 9,779.6 cubic yards rock and 18,735.6 cubic yards brush.

Under contract with James Short, work was commenced March 30, 1898, and contined until end of fiscal year. The shore protection opposite Turners Landing was extended 1,000 feet; a trailing dam from foot of Turners Island, with three transverse

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dams running to it from the Missouri shore, was nearly completed. A closing dam from Sandy Island to Missouri shore was finished, as also a wing dam above. Five submerged dams were built—two from upper end of Iowa Island and three from Illinois shore above Brocks Landing.

The total amount of material put in place in above work was 20,159.9 cubic yards rock and 36,303.8 cubic yards brush.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

Z 3.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open to navigation 253 days, during which time there passed through it 792 steamboats and 395 barges, carrying 22,984 passengers, 18,314 tons of merchandise, and 78,157 bushels of grain. There also passed through the canal 68,300,704 feet B. M. of lumber, 22,128,000 feet of logs, 22,697,900 shingles, and 27,100,150 laths.

The expenses of operating and care of the Des Moines Rapids Canal and Dry Dock have been, during the past year, $38,504.95, including outstanding liabilities. Repairs were nominal, and the dredging amounted to 54,551 cubic yards, which makes the aggregate taken from the canal since June 30, 1878, 1,159,301.3 cubic yards.

The dry dock was in constant use. Dockage fees were collected from private parties to the amount of $128.75.

Details of canal and dry dock operations may be found in appended report of United States Civil Engineer M. Meigs.

Money statement.

July 1, 1897, balance on hand	$6,723.13
June 30, 1898, amount drawn from Treasury during fiscal year, under indefinite appropriation	31,980.04
	38,703.17
June 30, 1898, amount expended during fiscal year	38,504.95
July 1, 1898, balance on hand	198.22

Abstract of appropriations and allotments.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, expended during fiscal year ending—	
June 30, 1882	41,771.17
June 30, 1883	77,926.79
June 30, 1884	43,283.42
June 30, 1885	44,506.50
June 30, 1886	43,009.53
June 30, 1887	42,152.84

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By act approved—Continued.

March 3, 1881, expending during fiscal year ending—Continued.

June 30, 1888	$42,802.35
June 30, 1889	38,885.37
June 30, 1890	43,995.80
June 30, 1891	44,998.20
June 30, 1892	43,968.92
June 30, 1893	57,057.21
June 30, 1894	55,356.48
June 30, 1895	41,052.80
June 30, 1896	37,555.21
June 30, 1897	33,440.54
June 30, 1898	38,504.95
Total expended	830,268.08

List of vessels docked in the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1898.

Designation.	Date of entering dock.	Date of leaving dock.	Remarks.
	1897.	1897.	
Canal flat H	.....	July 2	
Flat No. 44	.....	....do ...	
Guard lock boom	.....	July 28	
Grasshopper No. 142	July 2	July 14	
Flat Jumbo	July 3	....do ...	
Grasshopper No. 141	.....	Aug. 18	
Coal flat No. 54	July 27	July 28	
Steamer Linehan	Aug. 4	Aug. 4	Private owners.
Building boat No. 31	Aug. 10	Aug. 14	
Flat No. 44	Aug. 16	Aug. 18	
I. C. flat No. 30	Sept. 10	Sept. 13	
Steamer Line Hanson	Sept. 3	Sept. 5	Do.
Lower section lower lock boom	Sept. 13	Sept. 24	
Flat Jumbo	....do ...	Sept. 14	
Flat No. 7	Sept. 14	.....	Broken up.
Middle section lower lock boom	Sept. 27	Oct. 4	
Steamer Iris	Sept. 30	Oct. 1	
Upper section lower lock boom	Oct. 6	Oct. 9	
Coal flat No. 50	Oct. 16	Oct. 19	
Steamer Kit Carson	Nov. 1	Nov. 4	Private owners.
Steamer Lumberboy	....do ...	....do ...	Do.
Launch Onatoga	Nov. 6	Nov. 7	Do.
Flat No. 28	Nov. 1	.....	Broken up.
Dredge Phœnix	Nov. 15	Nov. 16	
Dump boat B	....do ...	Nov. 19	
Dump boat No. 7	Nov. 16	....do ...	
Dump boat No. 8	....do ...	....do ...	
		1898.	
Flat No. 154	Nov. 26	Mar. 26	
Flat No. 155	....do ...	Apr. 8	
Flat No. 158	....do ...	....do ...	
Flat No. 157	....do ...	Mar. 26	
Flat No. 159	....do ...	....do ...	
Flat No. 160	....do ...	....do ...	
Coal flat No. 53	....do ...	....do ...	
	1898.		
Steamer General Barnard	Mar. 26	Apr. 2	
Flat No. 154	Apr. 2	Apr. 8	
Flat No. 157	....do ...	....do ...	
Quarter boat No. 47	Mar. 26	Apr. 2	
Steamer J. G. Parke	Apr. 9	June 9	
Mississippi River Commission dredge Beta	....do ...	.....	Still in dock.
Mississippi River Commission flat No. 153	....do ...	.....	Do.
Flat No. 159	June 9	June 20	
Flat No. 160	....do ...	....do ...	
Flat No. 30	June 20	.....	Broken up.

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Detailed statement of expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1898, as required by section 4 of river and harbor act of July 5, 1884.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	1	Hired men	Services, June, 1897	$250.00
	2	....do	....do	1,970.00
	3	....do	....do	347.70
	4	E. H. Kellogg & Co	Oil	45.33
	5	Jones & Laughlins, Limited	Steel	2.02
	6	Mississippi Valley Telephone Co	Rent of telephones	10.50
	7	A. Weber Co	Oil cups, etc	3.15
	8	Smith Hardware Co	Brooms, brushes, etc	7.16
	9	Adams Express Co	Expressage	1.60
	10	Whitebreast Fuel Co	Coal	20.64
	11	Simmons Hardware Co	Hose	24.80
	12	The Sovereign Lubricating Co	Oil	5.13
	13	D. Santo	Subsistence	20.04
	14	H. C. Hodge & Sons	....do	31.43
	15	Hired men	Services, July, 1897	1,970.00
	16	T. Nodler	Subsistence	37.90
	17	D. Santo	....do	17.74
	18	Taber Lumber Co	Lumber	118.90
	19	J. F. Foelker	Veterinary services	2.00
	20	M. L. Boyles	Lumber	1.40
	21	Wilkinson & Co	Sponges, etc	4.20
	22	Kellogg-Birge Co	Soap	2.75
	23	Standard Oil Co	Oil	4.20
August	1	Hired men	Services, July, 1897	753.02
	2	....do	....do	250.00
	3	John T. Guyer	Services as diver	125.00
	4	Hired men	Services, August, 1897	20.24
	5	A. Weber Co	Iron, nails, etc	20.45
	6	McElroy Iron Works Co	Spars, etc	188.00
	7	Whitebreast Fuel Co	Coal	140.22
	8	Kollmyer & Talbot	Labor planing iron culvert gates.	8.80
	9	R. Heiser	Alcohol	2.60
	10	Henry Scharfenberg	Repairing public harness	3.85
	11	Standard Oil Co	Oil	24.79
September	1	Hired men	Services, August, 1897	1,962.50
	2	....do	....do	373.69
	3	....do	....do	125.00
	4	D. Santo	Subsistence	18.48
	5	T. Nodler	....do	32.09
	6	James McNamara	Cement	3.50
	7	The Philadelphia Lawn Mower Co	Pinions and pawls	.99
	8	St. L., K. & N. Railroad Co	Material and labor	147.36
	9	William W. Corey	Traveling expenses	16.80
October	1	Hired men	Services, September, 1897	1,970.00
	2	....do	....do	580.06
	3	D. Santo	Subsistence	7.78
	4	Smith Bros	....do	9.07
	5	Taber Lumber Co	Lumber	27.96
	6	Standard Oil Co	Oil	5.04
	7	Mississippi Valley Telephone Co	Rent of telephone	10.50
	8	Eagle Boat Store Co	Packing, etc	24.32
	9	Broderick & Bascom Rope Co	Wire rope	46.00
	10	Whitebreast Fuel Co	Coal	167.70
	11	Fifield Tool Co	Gears	2.00
November	1	Hired men	Services, October, 1897	1,890.00
	2	....do	....do	670.23
	3	T. R. Sutton	Valve and elbows	.70
	4	M. L. Boyles	Lumber	9.60
	5	D. Santo	Subsistence	19.16
	6	T. Nodler	....do	39.23
	7	A. Weber Co	Shovel, bolts, etc	1.30
	8	Mississippi Coal and Ice Co	Coal	38.00
	9	James McNamara	....do	93.00
	10	Louis Brown	Forage	32.27
	11	Hired men	Services, November, 1897	54.00
	12	Dan M. Gorman, administrator	Services John Ruse, dec'd	72.00
	13	Hired men	Services, November, 1897	175.00
	14	Anchor Line store	Hose, waste, etc	234.27
	15	T. Nodler	Subsistence, etc	31.45
	16	D. Santo	....do	12.71
	17	Hired men	Services, November, 1897	1,935.00
December	1	Hired men	Services, November, 1897	244.97
	2	McElroy Iron Works Co	Recasting iron	.91
	3	Wilkinson & Co	Glass	2.15
	4	James McNamara	Lime and cement	9.70
1898.				
January	1	Hired men	Services, December, 1897	1,542.50
	2	....do	....do	241.51

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Detailed statement of expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1898—Continued.

Month.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
January	3	Mississippi Valley Telephone Co	Rent of telephones	$10.50
	4	L. M. Rumsey Mfg. Co	Inspirator tubes	3.25
	5	Seither & Cherry Co	Stove castings, etc	16.40
	6	Mississippi Coal and Ice Co	Coal and coke	24.70
	7	Standard Oil Co	Oil	5.04
	8	Smith Hardware Co	Drills and iron	2.37
	9	Mississippi Coal and Ice Co	Coal	36.00
	10	Geo. B. Carpenter & Co	Hose	7.50
	11	P. H. Miller	Oats	26.00
	12	Wm. Rees & Co	Tags	1.10
	13	A. Weber Co	Leather belt, etc	4.09
	14	Hired men	Services, January, 1898	575.00
	15	do	do	121.75
	16	do	do	1,537.50
	17	McElroy Iron Works Co	Recasting iron	3.09
February	1	Annie Garland, administratrix	Services I. H. Garland, dec'd.	21.33
	2	Hired men	Services, February, 1898	1,605.00
	3	Mississippi Coal and Ice Co	Coal	36.00
	4	P. H. Miller	Hay	22.52
	5	Wilkinson & Co	Plumbago, etc	1.10
	6	Hired men	Services, February, 1898	75.22
March	1	Monmouth Mining and Mfg. Co	Pipe, tile, etc	61.00
	2	J. E. Lonergan & Co	Oil-cup glasses	2.55
	3	Osgood Dredge Co	Springs for dredge crane	9.75
	4	Standard Oil Co	Oil	37.35
	5	Smith Hardware Co	Leather belting	2.44
	6	Hired men	Services, March, 1898	1,647.50
	7	do	do	63.83
	8	Wilkinson & Co	Oil	18.21
	9	McElroy Iron Works Co	Recasting iron	7.97
	10	Hired men	Services, March, 1898	259.48
April	1	Mississippi Valley Telephone Co	Rent of telephones	10.50
	2	R. Crampton & Co	Stationery supplies	35.31
	3	Buck Reiner Co	Subsistence stores	135.15
	4	James McNamara	Cement	17.50
	5	P. H. Miller	Straw	1.80
	6	Henry Scharfenberg	Whip, etc	1.50
	7	Adams Express Co	Express charges	.70
	8	Bowman-Boyer Co	Grass seed	.70
	9	Hired men	Services, April, 1898	1,557.16
	10	do	do	2,030.00
	11	Smith Bros	Subsistence, etc	80.33
	12	D. Santo	do	129.57
	13	M. L. Boyles	Lumber	4.18
	14	W. P. Sutton	Steam connections	.90
	15	Hired men	Services, April, 1898	394.47
May	1	A. Weber Co	Belting, iron, etc	17.03
	2	McElroy Iron Works Co	Recasting iron	5.23
	3	Chisholm & Evans Co	Coal	20.40
	1	John Brehemy & Sons	Rebuilding wagon road	376.43
	2	John Ryland	Rebuilding wire fence	25.70
	3	J. W. Erman	Labor	13.50
	4	Buck-Reiner Co	Subsistence	66.53
	5	Whitebreast Fuel Co	Coal	542.36
	6	James McNamara	Fire brick	8.25
	7	Standard Oil Co	Oil	13.03
	8	Smith Hardware Co	Lawn mower	8.40
	9	John Brehemy & Sons	Rebuilding wagon road	207.20
	10	Hired men	Services, May, 1898	2,030.00
	11	do	do	1,577.50
	12	D. Santo	Subsistence	110.24
	13	Hired men	Services, May, 1898	555.63
June	1	do	Services, June, 1898	9.00
	2	W. P. Sutton	Pipe	1.86
	3	A. Weber Co	Solder	1.10
	4	Kellogg-Birge Co	Grass seed	3.90
	5	McElroy Irons Works Co	Recasting iron	8.59
	6	H. C. Hodge & Son	Subsistence	83.03
	7	Whitebreast Fuel Co. of Illinois	Coal	528.61
	8	Langstaff-Orm Manufacturing Co	Lumber	7.50
	9	P. H. Miller	Forage, etc	5.60
	10	Whitebreast Fuel Co. of Illinois	Coal	90.56
	11	Frank J. Weess	Subsistence	24.98
	12	H. C. Hodge & Son	do	36.90
	13	Mississippi Valley Telephone Co	Rent of telephones	10.50
	14	Hired men	Services, June, 1898	1,705.00
	15	do	do	447.72
	16	Western Union Telegraph Co	Telegrams	1.00

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Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1898.

Months.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1897.								
July	$750.00	.....	$12.10	$762.10	$3,944.01	$364.48	$982.29	$5,290.78
August	375.00	.....	.....	375.00	1,811.50	77.96	759.78	2,649.24
September	375.00	.....	10.50	385.50	1,770.00	215.35	496.38	2,481.73
October	375.00	$93.00	.....	468.00	1,877.00	331.36	391.13	2,599.49
November	375.00	.....	9.68	384.68	1,829.00	76.43	198.18	2,103.61
December	375.00	.....	10.50	385.50	1,167.50	7.41	261.46	1,436.37
1898.								
January	950.00	1.10	.....	951.10	1,183.83	33.50	146.93	1,364.26
February	375.00	.....	.....	375.00	1,230.00	23.62	93.22	1,346.84
March	375.00	35.31	10.50	420.81	1,389.67	27.78	208.05	1,625.50
April	375.00	.....	.70	375.70	1,877.50	2.20	153.47	2,033.17
May	375.00	.....	.....	375.00	1,958.75	112.09	813.89	2,879.63
June	375.00	.....	11.50	386.50	1,580.50	333.85	189.20	2,130.55
Total	5,450.00	129.41	65.48	5,644.89	21,614.16	1,606.03	4,693.98	27,914.17

Months.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1897.					
July	.....	.....	$22.05	$22.05	$6,074.93
August	.....	.....	.....	.....	3,024.24
September	.....	.....	.....	.....	2,867.23
October	.....	.....	.....	.....	3,067.49
November	.....	.....	9.87	9.87	2,498.16
December	.....	$24.70	.....	24.70	1,846.57
1898.					
January	.....	.....	18.00	18.00	2,333.36
February	.....	.....	18.00	18.00	1,739.84
March	$63.83	27.78	17.97	109.58	2,155.89
April	1,557.16	346.85	41.08	1,945.09	4,353.96
May	1,577.50	648.87	96.43	2,322.80	5,577.43
June	.....	435.83	39.97	475.80	2,965.85
Total	3,198.49	1,484.03	263.37	4,945.89	38,504.95

Comparative expenditures for operating and care of Des Moines Rapids Canal for the fiscal years 1890–1898.

Years.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1890	$4,425.00	$120.84	$238.03	$4,783.87	$18,245.07	$2,376.55	$7,848.88	$28,470.50
1891	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31
1892	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16
1893	5,720.00	137.13	138.73	5,995.86	17,464.67	2,162.64	6,822.35	26,449.66
1894	5,135.00	121.71	711.56	5,968.27	19,585.65	1,707.04	12,974.85	34,267.54
1895	5,083.00	156.38	314.92	5,564.83	19,264.68	2,004.19	7,712.16	28,981.03
1896	5,187.50	92.10	323.44	5,603.04	19,137.31	1,507.77	6,423.68	27,068.76
1897	5,050.00	157.83	83.98	5,291.81	16,814.34	1,111.45	4,534.57	22,460.36
1898	5,450.00	129.41	65.48	5,644.89	21,614.16	1,606.03	4,693.98	27,914.17

Years.	Dredging canal.				Grand total.
	Labor.	Supplies.	Repairs.	Total.	
1890	$3,196.58	$1,260.78	$6,284.07	$10,741.43	$43,995.80
1891	3,563.51	1,906.63	702.61	6,172.75	44,998.20
1892	11,333.23	6,370.52	4,259.47	21,963.22	51,550.17
1893	3,712.77	4,481.53	5,464.30	18,658.60	51,104.12
1894	6,719.81	2,227.41	7,716.02	16,663.24	56,899.05
1895	496.00	103.63	2,746.74	3,346.41	37,882.07
1896	3,056.94	1,385.42	441.05	4,883.41	37,555.21
1897	3,716.61	1,392.25	579.51	5,688.37	33,440.54
1898	3,198.49	1,484.03	263.37	4,945.89	38,504.95

For expenditures, 1882–1889, see Report Chief of Engineers, 1896, page 1823.

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Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1898.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Laths.	Lockage at one lock.
1897.					*Tons.*	*Bu.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	76	38	31	5,254	3,713	3,074					122
August	82	58	165	10,856	3,145	1,183	5,333,960		1,625,750	690,100	172
September	54	65	54	1,027	1,425		15,171,566	4,578,000	6,442,750	3,832,550	288
October	33	44	9	509	195	7,000	14,290,560	4,050,000	5,383,750	9,412,500	237
November	19	20	21	8	455		3,445,000	1,800,000	680,000	790,000	97
1898.											
March	7	9	8	46	363						20
April	37	37	19	334	1,887	36,000	1,834,757	2,100,000	535,000	1,037,000	162
May	57	48	20	1,144	4,484	21,200	12,987,861	8,400,000	4,997,400	4,109,000	530
June	70	38	68	3,806	2,647	9,700	15,237,000	1,200,000	3,033,250	7,229,000	174
Total	435	357	395	22,984	18,314	78,157	68,300,704	22,128,000	22,697,900	27,100,150	1,802

Comparative traffic statement showing the total traffic that has passed through the canal since 1890, by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockage at one lock.
			Number	*Tons.*	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1890	924	477	14,529	71,453	397,788	140,078,329	26,689,300	44,316,167	73,540,370	1,827
1891	878	357	15,801	45,217	364,878	193,358,089	37,176,150	59,350,595	87,259,690	1,805
1892	577	191	10,260	12,228	63,210	140,654,084	24,514,000	39,476,926	61,141,137	1,233
1893	670	234	10,846	33,318	53,257	80,190,519	16,350,200	28,896,260	29,121,020	1,476
1894	619	312	14,752	43,182	83,650	117,360,783	8,612,000	42,112,415	54,710,727	1,494
1895	606	340	14,141	22,034	55,729	155,625,800	29,545,910	55,064,938	55,670,204	1,503
1896	789	313	25,270	40,948	45,176	116,874,111	30,824,000	34,448,534	46,122,200	1,952
1897	760	272	21,778	40,365	54,345	101,645,575	13,616,000	28,834,220	28,866,520	1,443
1898	792	395	22,984	18,314	78,157	68,300,704	22,128,000	27,100,150	22,697,900	1,802

For traffic statement, 1878–1889, see Report Chief of Engineers, 1896, page 1824.

Dates of opening and closing of Des Moines Rapids Canal for years 1890–1898.

Years.	Canal opened.	Canal closed.	River opened.	River closed.	Highest water.		Lowest water.	
					Date.	Feet.	Date.	Feet.
1890	Apr. 1	Nov. 20	Jan. 28	Jan. 21	June 30	12.60	Jan. 3	—2.40
1891	....do ...	Nov. 21	Open.	No close.	Mar. 29	10.80	Nov. 30	—1.60
1892	....do ...	Nov. 23	Feb. 22	Dec. 23	June 30	19.25	Dec. 18	—0.80
1893	....do ...	Nov. 15	Mar. 10	Dec. 4	May 15	14.85	Nov. 20	—0.90
1894	Mar. 21	....do ...	Mar. 1	Dec. 30	June 3	11.35	Dec. 4	—0.90
1895	Mar. 15	Nov. 23	Feb. 26	Dec. 5	Mar. 4	5.10	Dec. 3	—1.40
1896	Apr. 1	Nov. 22	Mar. 3	Jan. 29	June 4	11.90	Jan. 3	—1.40
1897	Mar. 15	Nov. 21	Mar. 12	Dec. 28	Apr. 28	18.40	Dec. 4	—2.10
1898	Mar. 18	.....	Feb. 12	.....	.....	.....	.....	.....

For dates of opening and closing, 1877–1889, see Report Chief of Engineers, 1896, page 1824.

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REPORT OF MR. M. MEIGS, U. S. CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1898.

CAPTAIN: I have the honor to submit the following report on "Operating and care of Des Moines Rapids Canal and Dry Dock" for the fiscal year ending June 30, 1898:

The canal was closed November 22, 1897, and opened March 15, 1898, being open for navigation during the fiscal year two hundred and fifty-three days and closed one hundred and twelve days. No great high water occurred during the year, but a fair boating stage was the rule. The usual low-water periods in August and September were not experienced, the stage never falling below 1 foot at the Lower Lock.

Repairs to gates, machinery, and buildings.—The principal repairs to the canal have been the rebuilding of some of the stonework about the lower culvert openings at the Lower Lock and the completion of repairs to the filling and emptying culverts of the same lock. Guided by last year's experience, the caisson used in former repair work of this kind was discarded and a skillful diver employed to do the work, at a much less expense than with the use of a caisson and with equal results. In November the cold weather obliged us to stop work on the masonry repairs, which were finished in less inclement weather in April. The worn-out iron frames of the four west and two east filling culverts of the Lower Lock were replaced and the wearing parts of the gates repaired or new gates put in. This completes the repairs of the 16 culverts, the rest having been repaired in last fiscal year. Twenty years' service had completely worn out the frames, so that the gates would no longer operate properly.

The Guard Lock boom was taken into the dry dock in July, and the openings were found to be completely filled with mud, which loaded down the boom so heavily that it would barely float. The mud was cleaned out and the old fence cut up and used to fill these voids, adding greatly to its buoyancy. A counterpoise on outriggers of wood was added to the boom to increase its stability, and a new fence was built. This boom has been in service at the Guard Lock since 1888, with hardly any repairs.

The Lower Lock boom was taken into the canal by the canal launch *Lucia* in September, 1897, navigation outside of the canal being at that time suspended owing to low water. This boom was found filled with mud, like the Guard Lock boom, and for a great part of its length was submerged. The boom was docked at the dry dock, cleaned out, and the fence repaired, and was replaced, with the assistance of the *Lucia*, on March 31, 1898.

In November, 1897, drill boat *No. 6* was employed two days in replacing the mooring chain of the boom at the lower lock. This chain had pulled out, owing, probably, to imperfect bottoming of the pins in the rocks when the chains were first put in. The pins were found intact, but bent. The rock at that place is overlaid with 12 to 18 inches of gravel, and no doubt the holes had partly filled before the pins could be inserted. These pins were replaced with great care in new holes.

During the year the hydraulic pipes supplying pressure to the operating cylinders at the Middle Lock and Lower Lock have shown signs of deterioration. Four different leaks developed at different times at the Lower Lock and one at the Middle Lock. The pipes were dug up and repaired without difficulty, either by a clamp over the leak or by cutting out a short section of pipe and putting in new pipe.

Guard Lock.—New lagging was fitted to the boiler of the Guard Lock and the sheet-iron jacket repaired. The boom above the lock was cleaned and repaired. In September two spars were built and attached for operating the lower gates of the lock, thus finally discarding the original plan for operating these gates. Twenty years' experience shows that chains lying on the bottom, buried in mud, and catching all the trash that drifts along the bottom of a lock, should never be used to operate lock gates. Several serious interruptions to traffic and a final breakdown of the sheaves under the bottom of these gates hastened the change.

Middle Lock.—But few repairs were necessary at this lock during the year. Three stones of the upper miter sill lifted and one was drawn back with screw bolts. The miter sill is in bad shape and should be pointed and repaired at the close of the season if it lasts that long. This sill was probably damaged by the accident that destroyed the gates on April 2, 1894. The roof of the storehouse is old and the building should have sills and a new roof.

Lower Lock.—The repairs at this lock consisted in rebuilding the face of the walls about the east culverts, renewing 6 culverts and frames at the upper end of lock, repairs to boom, repairs to sheaves at bottom of upper east lock gates, repairs to leaks in hydraulic pipes, and ordinary repairs to machinery and valves of pump.

Machine shop at Lower Lock.—The shop has done a great deal of work on general repairs to canal plant and to dredge *Phœnix*, drill boat *No. 6*, the *Barnard*, *Parke*,

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Lucia, Louise, and *Stella.* Electric-light plants were overhauled, one new dynamo and engine built and put on the *Parke,* and a dynamo built and light fitted on the *Louise.* An experimental rudder was made for the *Barnard;* search-light reflectors replated for the *Stella, Louise,* and *Vixen;* dipper for the *Phœnix* rebuilt and strengthened, engines overhauled, hydraulic cylinders bored and new packing made, new dipper handle made; cylinders of drill boat *No. 6,* bushed and repaired; gate frames fitted and bolted to Lower Lock culverts; gates repaired, and much other work accomplished.

Dredging canal.—The *Phœnix* and *Vixen* were towed to the Lower Lock March 19 to receive new dipper handles, ship up rebuilt dipper, and for general overhauling before going into commission. On April 4 dredging was begun at Sandusky Creek and continued with double crew up to May 31, when the plant was transferred to Quincy Bay. During the months of April and May 54,551 cubic yards were dredged, distributed as follows:

Sections 63 to 64, Ballingers Creek	cubic yards..	1,326.2
Sections 50 to 53, Sandusky Creek	do....	23,226.1
Sections 40 to 41, Rickeys Creek	do....	1,139.2
Sections 26 to 29, Prices Creek	do....	28,859.5
Total		54,551

Of the total amount dredged, 4,428 cubic yards were removed from the mouth of Sandusky Creek as the result of a single heavy storm which occurred after the fleet had cleaned out the mouth of the creek, and to do this they had to return and do the work over again. From the mouth of this creek there were moved, in 1896, 15,436 cubic yards; in 1897, 29,730 cubic yards, and in 1898, 23,226 cubic yards. The material dredged at sections 40 and 41 was mostly gravel, and the greater part was loaded on scows and delivered to the contractor to put on the new road, thus saving the labor of towing it out into the river and at the same time putting it to a useful purpose.

Operating dry dock.—The dry dock has been in operation the whole year. A few outside boats have made use of it for emergency repairs, but on the whole it has been a dull year. The table submitted will show in detail the boats docked. During the winter the dock master alone was employed. Six large skiffs, 26 feet long, were built from material on hand. No new boats or barges were built during the year. Besides repairing a large number of flatboats belonging to the Alton fleet, the steamer *Parke* received heavy repairs—new cylinder timbers, much new decking and deck frames, new guards, new planking in rake and sides, wheel taken out, repaired, and put back, pillar blocks reset, and the boat made good for probably another five years. Steamer *Barnard* had calking and minor repairs; steamer *Line Hanson* sunk twice and was docked both times; steamer *Linehan* sunk, was raised and docked; dump boats of the *Phœnix* outfit repaired; Guard Lock boom docked, cleaned, and rebuilt; Lower Lock boom decked, repaired, and cleaned, and a great deal of general work accomplished. On April 1 the Mississippi River Commission dredge *Beta* entered the canal and was docked on April 9. This is the heaviest single craft ever docked at the dry dock, she having a displacement of 1,100 tons. The boat is being repaired and altered by contract, and the work progresses slowly. It looks as though it would be in the dock all summer. For these great iron dredges of great weight and cost the dry dock furnishes the only safe dock in the West. To preserve these boats it is necessary to dock and paint them periodically, and this can be done only here. An interesting use of the sand blast was made on the *Beta,* the rust being removed by sand blast before painting. The expediency and thoroughness of this method leaves nothing to be desired. There were repaired during the year 8 steamboats, 2 dredges, 1 pile driver, 1 quarter boat, 21 barges, 3 dump boats, 2 grasshoppers, and 2 booms. Dockage fees collected during the year amounted to $128.75.

Canal road.—Constant complaints of the condition of the county road bordering on the canal from above the Middle Lock to the Coey ice house, a distance of 4,000 feet, having been received by this office, a survey and report was made which showed that the road originally along the river bank was being encroached upon by the canal, and being flanked on the left by the railroad (unfenced), no removal or widening in that direction was possible. The width of the road had diminished so that in places less than 20 feet was left between the railroad and the steep bank of the canal. At times of flood the water of the canal was forced over the road, and its condition was always bad and dangerous. As the canal was greatly if not wholly responsible for this state of affairs, it was decided to build a new road west of the railroad track and turn it over to the county commissioners, provided they would furnish a right of way free of expense to the Government. Eight hundred dollars was set aside for this purpose, to be taken out of the canal allotment.

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Another piece of road at sections 42 to 46 of the canal was in a similar condition, having been removed by the United States to a low and marshy field, overflowed in time of high water in the upper level of the canal. Three hundred dollars was allotted, or as much as might be necessary, for the repair of this road, but this has not been expended so far, owing to the continued wet weather and unfavorable conditions.

I have been assisted by Mr. John R. Carpenter, overseer, Mr. Byron Layton, overseer, Mr. O. S. Willey, clerk, and Mr. W. F. Grady, copyist, at different times, Mr. Willey alone having been continuously at work in the office or works of the canal. To all of these my thanks are due for cheerful and efficient service.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

Z 4.

OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS.

During the past fiscal year the lock was open for navigation from July 1 to October 7, 1897, and from March 19 to June 30, 1898—a period of two hundred and two days—during which time there passed through 395 boats and barges, carrying 2,523 passengers and 2,237 tons of merchandise.

No dredging was done, although much was needed, for the bids of contractors for performing the work were so high that all were rejected. The old lock house—a frame shanty—was burned down, and it appearing desirable to build a new and better one, bids were called for, but in this case also they were so high as to be prohibitive.

The expenses of the fiscal year ending June 30, 1898, were $5,890.05, including outstanding liabilities, the same being provided for under section 4 of act of July 5, 1884.

Money statement.

July 1, 1897, balance on hand	$211.80
June 30, 1898, amount drawn from Treasury under indefinite appropriation	5,832.89
	6,044.69
June 30, 1898, amount expended during fiscal year	5,890.05
July 1, 1898, balance on hand	*154.64

Abstract of appropriations and allotments.

By act approved—	
September 19, 1890	$100,000.00
July 5, 1884, expended during fiscal year ending—	
June 30, 1894	635.68
June 30, 1895	6,000.00
June 30, 1896	3,400.00
June 30, 1897	8,588.20
June 30, 1898	5,890.05
Total	124,513.93

*Balance on hand July 1, 1897, was erroneously given as $241.80 in last year's report.

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Detailed statement of expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1898, as required by section 4 of river and harbor act of July 5, 1884.

No. of voucher.	To whom paid.	Superintendence and office expenses.	Operating.		Repairs to lock.	Total.
			Labor.	Supplies.		
	July, 1897.					
1	Hired men		$170.00			$170.00
2	.....do		188.00			188.00
	August, 1897.					
1	Hired men		170.00			170.00
	September, 1897.					
1	Kramer, Blener & Co	$5.50				5.50
	October, 1897.					
1	Hired men		170.00			170.00
2	Charles H. Miller	3.16				3.16
	November, 1897.					
1	Hired men		170.00		$706.40	876.40
2	J. C. McElherne	11.48				11.48
3	Standard Lumber Co				313.26	313.26
4	Langstaff-Orm Manufacturing Co				116.24	116.24
5	J. D. DuShane	10.95				10.95
6	Hired men		170.00		936.19	1,106.19
	December, 1897.					
1	Standard Lumber Co				90.11	90.11
2	Engler & Frudden Lumber Co				67.01	67.01
3	John M. Schaupp				28.95	28.95
4	John Wachenheim				18.00	18.00
5	The Engineering News Publishing Co.	6.40				6.40
6	The Inter Ocean Publishing Co	10.71				10.71
7	The Sayings Co	2.80				2.80
8	The Engineering Record	6.40				6.40
9	J. C. McElherne	30.76				30.76
10	Schreiber, Conchar & Westphal Co			$13.50		13.50
	January. 1898.					
1	Hired men		170.00		839.89	1,009.89
2	M. Slattery & Son				83.36	83.36
3	John Westwick & Son				20.88	20.88
4	Millhouse Bros				18.70	18.70
5	Casserly Bros				6.96	6.96
6	Stillman & Stahl				42.58	42.58
7	J. C. McElherne	28.62				28.62
8	Hired men				121.00	121.00
9	John Heid				7.43	7.43
10	Hired men	260.00	80.00		9.00	349.00
11	J. C. McElherne	6.55				6.55
	February, 1898.					
1	P. Kelly		80.00			80.00
	March, 1898.					
1	Hired men		128.00			128.00
	April, 1898.					
1	Wm. Siniger			22.30	29.10	51.40
2	Millhouse Bros			4.50		4.50
3	Hired men		170.00			170.00
	May, 1898.					
1	J. C. McElherne	5.36				5.36
2	Hired men		170.00			170.00
	June, 1898.					
1	Hired men		170.00			170.00

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Expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1898.

Month.	Superintendence and office expenses.	Operating.		Repairs to lock.	Total.
		Labor.	Supplies.		
1897.					
July		$358.00			$358.00
August		170.00			170.00
September	$5.50				5.50
October	3.16	170.00			173.16
November	22.43	340.00		$2,072.09	2,434.52
December	57.07		$13.50	204.07	274.64
1898.					
January	295.17	250.00		1,149.80	1,694.97
February		80.00			80.00
March		128.00			128.00
April		170.00	26.80	29.10	225.90
May	5.36	170.00			175.36
June		170.00			170.00
Total	388.69	2,006.00	40.30	3,455.06	5,890.05

Comparative statement of expenditures for operating and care of Galena River improvement for the fiscal years 1894–1898.

Year.	Superintendence and office expenses.	Operating.		Repairs to lock.	Dredging.	Total.
		Labor.	Supplies.			
1894	$7.17	$510.00	$4.84	$113.67		$635.68
1895	121.16	2,143.50	43.63	2,791.71	$900.00	6,000.00
1896	233.67	2,040.00	33.62	1,092.71		3,400.00
1897	228.05	1,615.00	30.52	85.42	6,629.21	8,588.20
1898	388.69	2,006.00	40.30	3,455.06		5,890.05

Traffic statement of the Galena River improvement for the fiscal year ending June 30, 1898.

Month.	Boats up and down.	Passengers.	Merchandise.	Lockages.
1897.			*Tons.*	
July	78	866	723	57
August	80	795	145	52
September	79	236	582	67
October	12	30	98	8
1898.				
March	12	16	34	12
April	34	65	325	32
May	49	132	260	48
June	51	383	70	50
Total	395	2,523	2,237	331

Comparative traffic statement showing total traffic that has passed through Galena River lock and the dates of opening and closing to navigation for the fiscal years 1894–1898.

Year.	Boats up and down.	Passengers.	Merchandise.	Lumber.	Shingles.	Laths.	Lockages.	River opened.	River closed.
			Tons.	*Feet.*	*Number.*	*Number.*			
1894	167	1,426	1,228					Mar. 12	Nov. 10
1895	471	4,798	1,939				320	Mar. 26	Nov. 21
1896	234	788	812	1,339,000	665,000	974,000	145	Apr. 4	Nov. 21
1897	265	714	1,679				141	Mar. 28	Nov. 17
1898	395	2,523	2,237				331	Mar. 10	

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Z 5.

ESTABLISHMENT OF HARBOR LINES AT DAVENPORT, IOWA.

OFFICE OF BOARD OF PUBLIC WORKS,
Davenport, Iowa, February 15, 1898.

DEAR SIR: By direction of the city council of Davenport, Iowa, I send you under other cover, by the United States Express Company, a map* showing the proposed dock line for the city of Davenport, Iowa. The city desires to fill the space between the proposed "dock line" and the present lease to a point about 1 foot above high water mark, except a space 150 feet wide to be built on a slope, and to be used as a landing for steamboats. I believe the map explains itself. It is the desire of the city council that you give the question of the "dock line" as early consideration as possible, as it has several ordinances pending relating to the levee, and it can not grant any further rights on the levee until the "dock line" is permanently established.

Yours, respectfully,

E. W. BOYNTON,
Commissioner of Public Works.

Col. A. MACKENZIE,
Corps of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 19, 1898.

Respectfully referred to Lieut. Col. William R. King, Corps of Engineers, for report.

To be returned.

By command of Brig. Gen. Wilson.

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Rock Island, Ill., March 2, 1898.

Respectfully returned to the Chief of Engineers, United States Army, attention being invited to report of this date, inclosed herewith.

W. R. KING,
Lieut. Col., Corps of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 8, 1898.

Respectfully submitted to the Secretary of War.

The city of Davenport, Iowa, requests the establishment of harbor lines along the Mississippi River in front of the city, and applies for permission to construct a bulkhead and to fill solid behind the same.

Attention is invited to report of March 2, 1898, on the subject, by Lieut. Col. W. R. King, Corps of Engineers, the local engineer, who

* Not printed.

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recommends that the lines proposed by the city as laid down (in red) on the accompanying tracing be approved.

I concur in his views and recommend that the Secretary place his approval both upon this paper and upon the map which has been prepared for his signature.

It is also recommended that the city of Davenport be authorized to fill solid behind the harbor line thus established, upon the following conditions:

1. That the river side of the work shall be a wall, bulkhead, or other permanent construction carried up to an elevation of one foot above high water and made perpendicular on the outside.

2. That between the Chicago, Rock Island and Pacific Railway bridge and the Renwick pier the bulkhead shall be extended and built in a very substantial manner for a distance of 1,400 feet above the bridge in a straight line from the north pier of the bridge toward the outside of the Renwick pier, the remaining section of 600 feet to be soon afterwards filled out, if needed, and in the meantime, if necessary, a sheer boom be placed there as required.

3. That the 1,400-foot section above the bridge shall be completed before any work whatever is to be attempted below the bridge.

A. MACKENZIE,
Acting Chief of Engineers.

[Fourth indorsement.]

WAR DEPARTMENT,
March 11, 1898.

Approved as recommended by the Acting Chief of Engineers.

R. A. ALGER,
Secretary of War.

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 22, 1898.

Respectfully returned to the Secretary of War.

Summary of case is given in third and fourth indorsements.

Lieutenant-Colonel King in communication of the 18th instant states that it is the desire of the Davenport people to give that part of the landing *below* the bridge the usual slope of river landings, viz, about 1 on 12. Only the part *above* the bridge was to be vertical. He recommends that the approval of the Secretary of War of March 11, 1898, be modified so as to permit the change desired and I concur in his recommendation.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Sixth indorsement.]

WAR DEPARTMENT, *March 26, 1898.*

Approved as recommended by the Chief of Engineers in the preceding (fifth) indorsement.

R. A. ALGER,
Secretary of War.

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REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island Ill., March 2, 1898.

GENERAL: I have the honor to submit the following report on the proposition of the city of Davenport, Iowa, to establish harbor lines:

On receipt of the papers and map an advisory board consisting of Assistant Engineers McElherne, Edwards, and Richards was appointed to examine the harbor and go over the proposed lines and report whether the filling as contemplated by the city of Davenport could be safely allowed without interfering with the navigation of the river. Their report, which appears to cover the ground very thoroughly, is as follows:

On February 23 the mayor, city engineer, and commissioner of public works were met by appointment, but, owing to absence of satisfactory information, the meeting was adjourned, and February 28 agreed upon as the time for a joint meeting to be held in order to secure if possible the attendance of all parties in any way interested in the matter. This latter meeting was well attended, and among those present were the mayor, city engineer, commissioner of public works, and many other officials, together with ten of the most prominent steamboat men and rapids pilots on this section of the river; also the board appointed by this office.

After some controversy, the project for that portion of the work below the Chicago, Rock Island and Pacific Railway Bridge met with the entire approval of all present; but as the river men were urgent in their demands for the full protection of their interests it was unanimously resolved—

"That the harbor lines be extended and built in a very substantial manner for a distance of 1,400 feet above the Chicago, Rock Island and Pacific Railway Bridge, in a straight line from the north pier of the bridge toward the outside of the Renwick pier (located 2,000 feet above said bridge), the remaining section of 600 feet to be soon afterwards filled out if needed, and in the meantime, if necessary, a sheer boom placed there as required.

"The river side of the work in question to be a wall, bulkhead, or other permanent construction, carried up to an elevation of 1 foot above high water and made perpendicular on the outside.

"The 1,400-foot section mentioned to be completed before any work whatever is to be attempted below the bridge."

The dotted red line on map indicates the outer edge of the proposed extension of the harbor lines, the lower portion of which shows, as specified, the initial section to be constructed.

Your Board, after careful consideration, recommends the approval of the harbor lines as proposed by the city of Davenport on the above-mentioned conditions.

I can see no serious objection to the lines as proposed and laid down in the tracing accompanying the original communication, and it is a pleasure to note an instance where a city proposes to provide a landing for itself without calling upon the General Government for an allotment from the appropriation for the general improvement of navigation.

It is probable that the high-water level will be slightly raised by the proposed filling, but it is thought that this will not amount to more than 6 inches, which will not be a matter of any serious inconvenience.

I would therefore respectfully recommend that the lines proposed by the city of Davenport, as laid down and described in the accompanying tracing, be approved, with the proviso that the filling first made be above the bridge for 1,400 feet. This requirement would remove the objection of the river men, and is, I understand, entirely satisfactory to the city of Davenport.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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APPENDIX A A.

CONSTRUCTION OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER FROM ST. PAUL TO MINNEAPOLIS, MINN., OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT ST. PAUL.

REPORT OF MAJ. FREDERIC V. ABBOT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Construction of Lock and Dam No. 2, Mississippi River, between St. Paul and Minneapolis.
2. Construction of reservoirs at head waters of Mississippi River.
3. Operating and care of reservoirs at head waters of Mississippi River.
4. Chippewa River, including Yellow Banks, Wisconsin.
5. St. Croix River, Wisconsin and Minnesota.
6. Minnesota River, Minnesota.
7. Red River of the North, Minnesota and North Dakota.
8. Gauging Mississippi River at or near St. Paul, Minnesota.

SURVEY.

9. Big Stone Lake and Lake Traverse, Minnesota.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., July 18, 1898.

GENERAL: I have the honor to transmit herewith reports upon the works for improvement of rivers in my charge for the fiscal year ending June 30, 1898.

* * * * * * *

Very respectfully, your obedient servant,
FREDERIC V. ABBOT,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN ST. PAUL AND MINNEAPOLIS, MINNESOTA: CONSTRUCTION OF LOCK AND DAM NO. 2.

[This work was in the charge of Lieut. Col. W. R. King, Corps of Engineers, to October 16, 1897.]

REFERENCE TO PAST REPORTS.

For original project for slack-water navigation, by Major Warren, see Annual Reports, Chief of Engineers, for 1867, p. 259; 1874, p. 287;

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1881, p. 1747. For survey and estimates for locks and dams, by Major Allen, see Annual Report, Chief of Engineers, 1888, p. 1563. For removal of bowlders, Report of 1891, p. 2148. Revival of recommendation for slack-water navigation, Report of 1892, p. 1781. Surveys for lock at Meekers Island ordered, Annual Report, 1893, p. 2202. Detailed project and estimate under which work is now in progress. Annual Report, Chief of Engineers, 1894, p. 1682.

WORK OF PAST YEAR.

During the year the necessary land has been secured for the lock and dam, and for the plant to be used in the construction thereof. A detailed plan with drawings was prepared and submitted for approval, authority being asked to begin hired labor work at once on the procuring and erection of the plant and cofferdam, but further time being asked for the more complete study of the details of the lock and dam. The authority was granted subject to the restriction that no work of actual construction of the lock should begin until the approval of a board of engineers was obtained. Under this authority a complete traveling cableway spanning the river has been purchased and will be nearly erected by the close of the year. A complete plant for crushing stone has been purchased and delivered at the site. Necessary carpenter and blacksmith shops have been built. A good road down the face of the bluffs has been graded, an artesian well has been bored, insuring a constant supply of pure cold water for drinking, for boilers, and for the intercoolers of an air-compressing plant, which has been contracted for, but which had not been delivered at the close of the year.

The difficulty of using steam power in the bottom of a deep gorge, without any areas on either side of the river above the level of high water, made it imperative to place the main power house on top of the bluff, and transmission by compressed air proved to be much the most convenient and economical method of operating the pumps and other machinery on the cofferdam and inside of it. There is every prospect of having to control large volumes of water when the cofferdam is pumped out, as the sand rock to be excavated is full of springs under considerable head, and in places fissures of considerable area are indicated. With an ample supply of compressed air these difficulties can be met and overcome, while an attempt to otherwise cope with them would be much more difficult, dangerous, and expensive.

The arrangement of plant adopted for concrete mixing is peculiarly effective and convenient. The crusher is located just below the top of the bluff, so that its hopper is level with the general surface of the ground. The crushed stone falls by gravity from the crusher into a series of pockets or bins in which 1,400 cubic yards of crushed stone can be stored. From the bins the stone runs by gravity into cars which carry it down grade to the top of the mixer, which is located on the face of the bluff below and a little to one side of the bins. The cement and sand are added to the charge of broken stone as the car passes from the stone bins to the mixer, the cement warehouse and sand bins being so located as to make this possible with the least labor. From the mixer the concrete falls by gravity into two-yard tubs, on small flat cars which carry it down grade to a point beneath the cableway. The tubs are lifted by the cableway, run to the point they are to be dumped, are there dumped and returned to the empty flat car by the cableway. In

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this way no materials are required to be handled by manual labor from the time they enter the crusher until they are in place to be rammed in forms. Water is added to the mixer from a tip tank which permits an exact proportioning of the water to each charge according to the hygrometric conditions of sand and stone at the time the charge is to be mixed.

The use of compressed air makes it possible to place the various engines needed for the above scheme of plant at any points on the face of the bluff, as there are no small boilers to be supplied with fuel and water. The cost of a number of stokers is thus dispensed with and a great saving is possible, as one expert steam engineer at the compressor house can overseer the several engines, which can be safely run with compressed air by a class of operatives much less highly salaried than would be the case if each engine had its own boiler and other appurtenances.

An informal contract for supplying 3,000 tons of small granite bowlders, which are numerous near the site, has been let and 7,000 tons more will be advertised for. The price for the first lot of 3,000 tons was $0.90 per ton of 2,000 pounds, delivered at the site on top of the bluff.

The detailed plans for the lock and dam have been nearly completed ready for action by a board, but their completion will be somewhat delayed by the appointment of my principal assistant engineer, Mr. A. O. Powell, as a captain in the Second Regiment of United States Volunteer Engineers, and by the enlistment of my instrument man, Mr. H. Vansant, who also acted as draughtsman, as a sergeant in the same regiment. Mr. Powell's excellent judgment and mathematical ability, combined with a good knowledge of practical machinery and long familiarity with the hydraulics of dams, bear-trap gates, and sluiceway constructions, has made his service during the whole period of my association with him in this district of the greatest value. Many of the best features in the designs for the lock and lock gates were original with him.

There has been no commerce over this section of the river during the year except that of floating logs to market. No other kind has been possible on account of the swift current and numerous rocks and bowlders.

Amount expended to June 30, 1897, excluding outstanding liabilities	$16,121.63
Amount expended during fiscal year ending June 30, 1898, excluding outstanding liabilities	19,709.09
Outstanding liabilities, June 30, 1898	25,869.66

The expense properly chargeable to the fiscal year 1898 has been divided as follows:

Superintendence, contingencies, and St. Paul office	$5,285.67
Land	4,879.10
Cableway account	4,167.25
Surveys	106.88
Lock keeper's house	150.00
Buildings	996.31
Road, etc	2,033.28
Tools	622.04
Air-compressor account	35.02
Fuel	108.78
Miscellaneous	328.79
Total	18,713.12
Add expenditures of Rock Island office prior to October 16, 1897	995.97
Total expenditures during fiscal year	19,709.09

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Money statement.

July 1, 1897, balance unexpended	$184,756.04
June 30, 1898, amount expended during fiscal year	19,709.09
July 1, 1898, balance unexpended	165,046.95
July 1, 1898, outstanding liabilities	25,869.66
July 1, 1898, balance available	139,177.29
Amount (estimated) required for completion of existing project	397,357.33
Amount that can be profitably expended in fiscal year ending June 30, 1900	397,357.33

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations.

By act approved—	
August 18, 1894	$51,000.00
July 13, 1892 (allotted by act of August 18, 1894)	49,877.67
By act of June 3, 1896	100,000.00
Total	200,877.67

A A 2.

CONSTRUCTION OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

REFERENCE TO PAST REPORTS.

For original plans and surveys, see Annual Report of the Chief of Engineers, 1870, p. 285; 1875, p. 441; 1879, p. 1206; 1881, pp. 1761 and 2748; 1882, p. 1830; 1885, p. 1749. Report of Board of 1880. Annual Report of the Chief of Engineers, 1881, p. 1763. Modifications, Annual Report of Chief of Engineers, 1883, p. 1472. Effects on low-water stages, Annual Report of the Chief of Engineers, 1886, p. 1503; 1887, p. 1669. Board of 1887 disapproved extension to St. Croix, Chippewa, and Wisconsin rivers, Annual Report of the Chief of Engineers, 1887, p. 1680. Description of dams, 1881, p. 1763; 1883, p. 1456; 1887, p. 1667. History, 1892, p. 1824. For Secretary of War Regulations for operating, see p. 1830, Report for 1896.

MISCELLANEOUS.

At the time the system of reservoirs was inaugurated they were situated in a wilderness and no method of transporting cement or other permanent building material for dam construction was available. The lands to be overflowed had no commercial value. The country is now settling rapidly, railroads are built or building, and land has considerable value. The five completed dams were built of timber and the older ones are much decayed. A sixth was appropriated for, provided the necessary land for the reservoir could be had for $15,000. The land can not be had for this amount and the capacity of the projected reservoir is so small as not to justify the expenditure of a larger sum. The timber portions of the dams at Winnibigoshish and Leech lakes are so rotten that complete repairs must be made before it will be safe to again fill the reservoirs they form. Their sites can now be reached

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by rail and the timber portions should be replaced with permanent masonry, probably concrete. The dam at Pokegama is in good order and will last without large repairs for several years. That at Pine River should have the timber portions replaced by concrete in three or four years. Sandy Lake dam is in good condition, and will probably last six or eight years before large repairs are necessary.

WORK OF PAST YEAR.

No work of construction has been done. Surveys have been made below Pokegama Dam to show what lands are submerged by the legitimate service of the reservoir, so that flowage rights may be secured. A number of such easements have been purchased, but there are a number of lots in the towns of Grand Rapids and Laprairie, Minn., which belong to parties whose addresses are unknown. Some form of condemnation proceedings must be had before clear rights to overflow these unclaimed lots can be vested in the United States. Efforts to secure title to the lands on which the ends of the dam itself rest have been continued during the year, and an amicable agreement was made with Mr. W. H. Grant, jr., who is the prima facie owner of the land at the north end of the dam, but up to the close of the fiscal year he had not been able to make a title satisfactory to the Attorney-General of the United States. The land on which the south end of the dam rests is owned by a party who is unwilling to sell outright, but he has executed a deed giving the necessary easements to the United States, and waiving any claims for damages for the occupation of his lands in the past.

A number of claims for damage by reservoir water have been investigated during the year, and, where they have been well founded, easements have been secured to permit the flowage in the future. In all such cases back damages have been waived by the grantors. In general an earnest effort has been made to find out exactly what lands we do overflow, and, if the United States had not already secured the legal right, flowage easements have been obtained if possible. To properly adjust these questions accurate surveys are urgently needed, as the original surveys were made when the lands had no value, and are such rough approximations that no reliance can be placed in the flowage lines shown on the official maps. They differ widely from the true lines wherever new surveys have been made. To make the necessary surveys will require about two years and will cost $30,000. This is based on working throughout the year, as winter work has proved to be no more expensive than summer. The ease of getting the parties round on the ice and snow more than counterbalances the difficulty of working in the winter cold and wind. During the year a party has completed a survey of the south side of Pine River Reservoir. It shows that the original maps were very inaccurate, and that the break reported in the Annual Report of the Chief of Engineers for 1896, page 1844, was caused by the flow of water through a natural low place in the sand ridge, and not by the cutting of a logging road. This makes the claim of Mr. A. T. Kimball for damages to his property a peculiarly just one. The amount of damage to Mr. Kimball has been estimated by this office at $2,500, and this amount has been accepted as just by him. The amount should be appropriated by Congress. Several other places well below the level of the projected flowage were found. The reservoir had never been filled so nearly to its capacity before 1896, and these outlets had thus never shown themselves before. The break occurred at a level 3 feet below that for which the reservoir was

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planned, and this proves the absolute necessity of new and accurate surveys before trying to fill any of the reservoirs higher than they have been tested by actual use. As neither Leech Lake nor Winnibigoshish reservoirs have ever been filled to more than two-thirds of their capacity (see diagram appended to this report), this means that the two large main reservoirs can not be safely filled until the surveys above referred to have been made and plotted. It is not believed that such surveys of completed reservoirs could be properly made under the appropriation for construction of reservoirs without explicit authority of Congress.

Further study of the question of damming Crow Wing River and storing its flow in the proposed Gull Lake Reservoir has shown the project to be chimerical. The expense would be out of all proportion to the benefits secured. As a general conclusion, it seems safe to state that the increase in value of land has made it no longer a question of building new reservoirs, but of completing and making permanent those already built, and of locating and paying for the large areas which it is believed the United States has submerged without proper compensation. The sooner this is done the less will be the cost of paying for these lands, as their value is rapidly increasing as the region becomes more densely settled. Certain Indian lands are also involved, and, unless the limits of flowage can be given accurately to the Interior Department, these lands will soon be opened to homestead or division in severalty, and what could now be secured for nothing, as the Indian damages have been paid to the extent of $150,000 by a special act of Congress, will have to be repurchased from bona fide holders, probably at high figures.

The reconstruction of Winnibigoshish Dam in concrete will cost closely $100,000, and until the total amount is provided no work can begin, as it is all in one cofferdam, and must be completed as soon as possible after work begins, as the total flow of the Mississippi will have to be stored in the reservoir till the sluices in the new dam can be operated.

Leech Lake Dam should be repaired the following season, and the cost will be $100,000. There is less height of dam but a much greater length of timber work to be replaced with permanent construction.

The hydrological party stationed at St. Paul was discontinued early in December, the amount allotted for gauging having been exhausted. No advantage is seen in prosecuting this hydrological work unless it is made much more complete by a system of parties at numerous points below as well as above St. Paul to trace the exact effects of the release of reservoir waters. It is believed that careful measurements for a short time before and after opening the reservoirs at the summer low-water season will give all the data that is really valuable. These observations can not be made this season on account of the failure of Congress to pass a river and harbor bill at this session. The gaugings at the reservoir dams are essential to their proper operation, and, being made by the regular dam tenders, cost nothing. They give excellent data for computing the proportion of run-off, as the dam tenders are also required to keep complete meteorological records.

The steamer *General Poe*, mentioned on page 2139, Annual Report of 1896, proved too expensive for the work she had to do, so she was taken out of the water and laid up. The small amount of freighting and other transportation required can be more cheaply effected by hiring local boats when occasion demands.

Amount expended to June 30, 1897, excluding outstanding liabilities, $833,453 61.
Amount expended during the fiscal year, excluding outstanding liabilities, $7,927.70.
Outstanding liabilities, June 30, 1898, $461.67.

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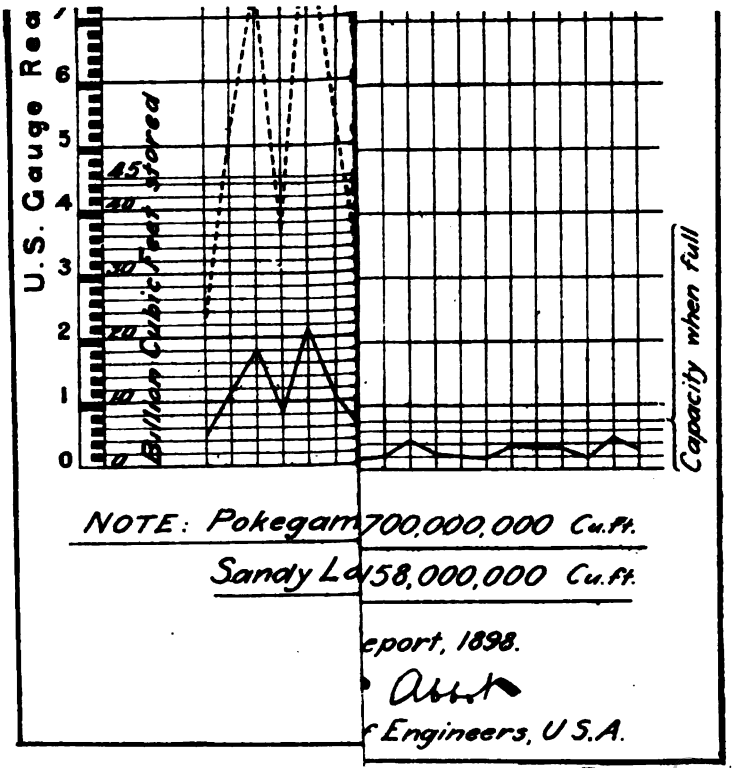

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The expense chargeable to the fiscal year has been divided as follows:

Pokegama Falls Reservoir:		
Steamboat	$139.39	
Land	2,746.33	
		$2,885.72
Gull Lake and Crow Wing River Basin: Survey		66.67
Pine River Reservoir: Survey		1,136.28
Hydrological expenses:		
St. Paul Station	$9.03	
Anoka Station	776.75	
Crow Wing Station	284.65	
General	30.00	
		1,100.43
Superintendence, contingencies, and St. Paul office		2,738.59
Total		7,927.70

The estimate of money required is as follows:

Surveys of all reservoir flowage lines	$30,000
Repairs to Winnibigoshish Dam	100,000
Repairs to Leech Lake Dam	100,000
Pine River dikes	10,000
Contingencies, say	30,000
Total	270,000

There is now appropriated for Gull Lake Reservoir $55,000. At least this sum will be required for payments for lands we now occupy without legal right, if the new surveys verify the indications of the partial surveys actually made. As the construction of Gull Lake Reservoir is not recommended, the $55,000 now held in hand for building that reservoir should be made available for the purchase of lands and execution of the surveys referred to.

For commerce benefited by the reservoirs, reference must be made to the commercial statistics pertaining to the Lower Mississippi River.

Money statement.

July 1, 1897, balance unexpended	$72,046.39
June 30, 1898, amount expended during fiscal year	7,927.70
July 1, 1898, balance unexpended	64,118.69
July 1, 1898, outstanding liabilities	461.67
July 1, 1898, balance available	63,657.02
Amount that can be profitably expended in fiscal year ending June 30, 1900 * Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	270,000.00

Abstract of appropriations.

By act—		By act—	
Approved June 14, 1880	$75,000	Approved September 19, 1890	$80,000
Approved March 3, 1881	150,000	Approved July 13, 1892	60,000
Passed August 2, 1882	300,000	Of August 18, 1894	51,000
Approved July 5, 1884	60,000	Passed June 3, 1896	80,000
Approved August 5, 1886	37,500		
Of August 11, 1888	12,000	Total	905,500

*Required for renewal and repair of reservoir dams, as contemplated in the general deficiency act, approved July 7, 1898.

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A A 3.

OPERATING AND CARE OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

REFERENCE TO PAST REPORTS.

For capacities of reservoirs, map of region, and comparison of rainfall and run-off, see Annual Report Chief of Engineers, 1896, p. 1841. For break in Pine River Reservoir, see Annual Report, 1896, p. 1844, and 1897, p. 2144. For diagram showing how much water has been stored each year in each reservoir, see this year's report on Construction of Reservoirs at Head Waters of Mississippi River.

WORK OF PAST YEAR.

The dams were operated and small current repairs were made. A change in the method of supplying the men in charge was made. Formerly they were subsisted by the United States, as it was impossible for them to obtain their own supplies in such a sparsely settled region at any reasonable cost. Railroad facilities have now increased so that the pay of the principal dam tender has been raised $25 a month and he is required to board the assistant dam tender free of charge. The system has worked well and has resulted in a considerable saving to the United States.

Winnibigoshish and Leech Lake dams are in need of such extensive repairs that their reservoirs can not be again filled before such repairs are made. After releasing the water stored in them this spring, which will be done during the low-water period of the coming summer and fall, the sluice gates in both of the dams will be opened, and no attempt to store any water in these reservoirs will be made. To do otherwise would be to court disaster to all the territory below the dams for some distance.

Expenditures to June 30, 1897, $72,396.75.
Amount expended during fiscal year ending June 30, 1898, exclusive of outstanding liabilities, $20,497.19.

Expense chargeable to fiscal year 1898 has been divided as follows:

Pokegama Falls Dam:		
Operating	$1,697.42	
Repairs	144.62	
Land condemnation	207.40	
		$2,049.44
Leech Lake Dam:		
Operating	1,251.02	
Repairs	163.95	
		1,414.97
Lake Winnibigoshish Dam:		
Operating	1,734.67	
Repairs	158.41	
		1,893.08
Pine River Dam:		
Operating	1,770.41	
Repairs	368.05	
Crevasse	1,329.72	
		3,468.18
Sandy Lake Dam:		
Operating	2,430.44	
Repairs	671.92	
		3,102.36
Superintendence, contingencies, and St. Paul office		3,184.17
Operating steamboat *General Poe*		1,692.22

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Hydrological expenses	$1,109.99
Operating expenses applicable to all reservoirs	2,175.77
Road between Leech Lake and Winnibigoshish Lake	407.01
Total	20,497.19

For commercial statistics reference must be made to the reports upon the improvement of the Mississippi River.

Money statement.

July 1, 1897, balance unexpended	$2,734.18
Allotted August 4, 1897	23,870.00
Repayments	38.54
	26,642.72
June 30, 1898, amount expended during fiscal year	20,497.19
July 1, 1898, balance unexpended	6,145.53
July 1, 1898, outstanding liabilities	1,763.33
July 1, 1898, balance available	4,382.20

Abstract of expenditures by fiscal years.

During fiscal year ending June 30, 1895	$6,416.19
During fiscal year ending June 30, 1896	30,800.15
During fiscal year ending June 30, 1897	35,180.41
During fiscal year ending June 30, 1898	20,497.19
Total	92,893.94

Abstract of allotments.

January 25, 1895	$17,590.00
June 15, 1895	18,852.91
June 20, 1896	5,000.00
July 24, 1896	23,471.98
For repairs to Pine River Reservoir	7,481.86
August 4, 1897	23,870.00
Total	96,266.75

Itemized statement of expenditures during the fiscal year ending June 30, 1898.

Date.	To whom paid.	For what paid.	Amount.
1897.			
July 1	Sundry persons	Pay roll for June	$993.92
6	do	do	213.88
	do	do	141.50
	Robert A. Smith, P. M.	P. O. box rent	1.50
	R. Davenport, Assistant Engineer	Travel expenses	2.30
	Neil McKay	Use of team	21.00
	Kuhlo & Ellerbe	Drawing materials	39.06
	Sundry persons	Emergency purchases	19.23
	do	do	22.95
	A. Ostland	Team hire	20.00

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Itemized statement of expenditures during the fiscal year ending June 30, 1898—Cont'd.

Date.	To whom paid.	For what paid.	Amount.
1897.			
July 6	A. T. Kimball	Use of team	$20.00
9	Sundry persons	Pay roll for June	747.50
12	C. L. Maynard	Butter	9.80
	Thorp & Martin Co	Stationery	8.50
	S. & J. W. Koop	Supplies	43.81
	....do	Feed and oats	40.66
	W. Potter & Co	Oilcloth	7.33
	Boeringer & Co	Drawing materials	106.53
	Cross Lake Logging Co	Lumber, etc	83.25
	Archie Purdy	Use of team	6.00
	D. M. Clark & Co	Hardware, etc	39.15
16	North American Telegraph Co	Telegrams	4.10
	Western Union Telegraph Co	....do	2.66
	G. W. Knox	Ink	.60
	Slipp Bros	Coal and iron	7.63
26	Northern Pacific Express Co	Express charges	15.40
31	Sundry persons	Pay roll for July	320.00
	Western Union Telegraph Co	Telegrams	9.24
Aug. 5	Sundry persons	Pay roll for July	372.95
	....do	....do	686.33
	....do	....do	110.00
12	....do	....do	148.00
	Northern Pacific Express Co	Express charges	6.15
	Sundry persons	Emergency purchases	47.82
13	Griggs Bros	Sacks	115.74
	G. W. Knox	Feed, lumber, etc	50.90
19	W. J. & H. D. Powers	Hardware	9.61
	Cluff Bros	Hauling	37.70
	Duluth, Superior and Western Railway Co	Rental	10.66
	Itasca Mercantile Co	Mess supplies	116.45
	....do	....do	438.38
	Archibald Johnson	Travel expenses	5.25
23	The Western Supply Co	Vise	7.20
	Robinson & Cary Co	Anvil, etc	29.80
	Sundry persons	Pay roll for August	75.50
31	....do	....do	307.50
	Buff & Berger	Repairs	9.20
Sept. 13	Sundry persons	Pay roll for August	787.90
	....do	....do	149.75
	....do	....do	110.00
15	Sam. V. Morris	Services	75.00
14	N. H. Witt	Subsistence	3.47
15	Cluff Bros	Hauling	19.59
	St. Paul Gas Light Co	Gas	1.04
	Archie Purdy	Team hire	6.00
	Patrick Henry	Travel expenses	.85
	George Snetsinger	....do	6.90
	Buff & Berger	Repair work	29.02
	Board of Water Commissioners	Water	3.81
	E. P. Wakefield	Meat	5.15
	W. Potter & Co	Groceries	161.23
	Sundry persons	Emergency purchases	71.04
	Robinson & Cary Co	Blocks, etc	39.82
	Itasca Mercantile Co	Pork	11.50
17	Sundry persons	Emergency purchases	15.00
20	W. A. Jones, Lieutenant-Colonel Engineers	Mileage	19.94
23	Chas. Wilson	Transportation	6.41
	Adams Express Co	Express charges	1.05
	W. L. Wakefield	Cranberries	3.50
	W. J. & H. D. Powers	Hardware, etc	45.69
	W. B. Gwathniey	Repair work	1.50
24	Sundry persons	Part pay roll (office)	568.75
Oct. 1	....do	Pay roll for September	829.31
	....do	....do	110.00
	....do	....do	147.50
	....do	Pay roll September (office)	166.00
6	Frank N. Allen	Services	9.00
18	Louis Porrier	Cord wood	24.38
	Sundry persons	Emergency purchases	42.29
	W. Potter & Co	Paint	3.00
	Archibald Johnson	Travel expenses	7.70
25	Adams Express Co	Express charges	.75
	Capt. Frederic V. Abbot	Mileage	8.62
	W. T. Hutchins	Services	69.00
26	Richard Relph	....do	78.00
Nov. 5	.... do	....do	12.00
	Sundry persons	Pay roll for October	755.00
	Col. J. W. Barlow	Mileage	46.28
	Sundry persons	Pay roll for October	144.50
	....do	....do	110.00

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Itemized statement of expenditures during the fiscal year ending June 30, 1898—Cont'd.

Date.	To whom paid.	For what paid.	Amount.
1897.			
Nov. 5	Board of Water Commissioners	Water	$1.75
	George D. Davis	Team hire, etc	11.00
	St. Paul Gas Light Co	Gas	.15
	August Schuetze	Services	35.00
	Capt. Frederic V. Abbot	Mileage	15.26
9	H. H. Perrine	Services	117.00
	Patrick Henry	Travel expenses	13.46
13	Capt. Frederic V. Abbot	Mileage	30.28
	W. Potter & Co	Bran and oil meal	13.35
	North American Telegraph Co	Telegrams	4.47
	Ballard City Express Co	Drayage	5.00
	Griggs & Co	Candles	.75
17	St. Paul Gas Light Co	Gas	.52
	Board of Water Commissioners	Water	1.25
19	Sundry persons	Emergency purchases	10.00
	Adams Express Co	Express charges	6.60
22	George Muller	Skiff	34.00
30	Beckfelt & Mather	Subsistence	70.56
	Robinson & Cary Co	Rope	29.84
	Sundry persons	Emergency purchases	10.54
	J. A. Quigg	Meals	2.00
	W. J. & H. D. Powers	Repairs, etc	9.63
	Western Union Telegraph Co	Telegrams	45.48
	J. F. Metzger	Fresh meat	31.60
Dec. 1	Richard Relph	Services	90.00
	Sundry persons	Pay roll for November	369.22
	....do	....do	206.00
	Oppenheim & Kalman	Rent of storeroom	60.00
4	Sundry persons	Pay roll for November	80.00
	Board of Water Commissioners	Water	1.25
	Sundry persons	Pay roll for November	116.00
8	D. D. McLennan	Services	8.33
	Alexander Kittson	Fresh meat	2.84
	W. S. Cluff	Transportation	6.80
	Charley Drumbeater	Fresh meat	5.00
	Sundry persons	Pay roll for November	110.00
	Northern Pacific Express Co	Express charges	.60
17	A. Purdy	Team hire	25.00
	Sundry persons	Emergency purchases	15.18
	....do	....do	2.25
20	George Snetsinger	Travel expenses	6.15
27	H. Rosenblatt	Hay	7.00
	Muck Bozeal	....do	4.00
	Archibald Johnson	Travel expenses	6.22
1898.			
Jan. 6, 7	Sundry persons	Pay roll for December	238.00
6	....do	....do	359.00
	....do	....do	80.00
	....do	....do	116.00
	M. V. Fuller & Co	Lumber and tarred paper	19.57
7	J. A. Quigg	Meals	2.00
11	Sundry persons	Pay roll for December	110.00
13	W. J. & H. D. Powers	Gas pipe	16.00
	Brainerd & Northern Minnesota Railway Co	Transportation	4.70
	W. Potter & Co	Hardware	2.60
14	D. D. McLennan	Services	10.00
	James Tierney	....do	2.00
	Duluth, Superior & Western Railway Co	Transportation	20.72
	St. Paul Gas Light Co	Gas	.65
	Kuhlo & Ellerbe	Meter repairs	1.75
	Thompson Rubber Co	Mop wringer	1.75
	Robinson & Cary Co	Steam hose and fittings	32.00
19	Charley Drumbeater	Fresh meat	3.90
	J. A. Quigg	Meals and lodging	5.50
25	Northern Pacific Express Co	Express charges	.30
	Northwest Engineering Co	Sal-ammoniac, etc	.75
29	E. A. Brown	Repairs to timer	1.50
	Adams Express Co	Express charges	1.60
	Eugene Libby	Hay	5.00
Feb. 2	Sundry persons	Pay roll for January	155.00
	Western Union Telegraph Co	Telegrams	16.04
	Duluth, Superior and Western Rwy. Co	....do	.59
	Sundry persons	Pay roll for January	305.00
4	D. D. McLennan	Services	10.00
	Smith & Riddell	Flanges	1.50
	W. V. Fuller & Co	Lumber	54.00
	Adams Express Co	Express charges	1.65
5	Sundry persons	Pay roll for January	121.00
	....do	....do	80.00
	Brown, Tracy & Co	Stationery, etc	8.92

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Itemized statement of expenditures during the fiscal year ending June 30, 1898—Cont'd.

Date.	To whom paid.	For what paid.	Amount.
1898.			
Feb. 8	Sundry persons	Pay roll for January	$123.00
21	Itasca Mercantile Co	Paper, nails, etc	17.65
	Beckfelt & Mather	Mess supplies	414.94
	St. Paul Gas Light Co	Gas	.13
Mar. 1	Bert Campbell	Travel expenses	1.50
	St. Paul and Duluth R. R. Co	Transportation	10.54
2	Sundry persons	Pay roll for February	355.00
	.....do	.....do	105.00
	.....do	.....do	116.00
	D. D. McLennan	Services	10.00
4	Sundry persons	Pay roll for February	86.00
	.....do	.....do	80.00
	George Snetsinger	Travel expenses	9.50
14	Sundry persons	Part pay roll, March	233.00
23	Pullman Palace Car Co	Transportation	16.00
	Adams Express Co	Express charges	1.35
	F. E. Messing	Stamp	.30
29	A. L. Hannan & Co	Clock	4.00
31	Sundry persons	Pay roll, March, part	358.58
Apr. 2	.....do	Pay roll for March	355.00
4	.....do	.....do	115.00
	.....do	.....do	105.00
	Will Nisbitt	Repairs to timber	1.00
	Mrs. Mary Denesen	Washing towels	4.50
7	Sundry persons	Pay roll for March	80.00
	Northwestern Telephone Exchange Co	Telephone service	5.90
	McQuillan Bros	Plumbing	20.00
11	Sundry persons	Pay roll for March	80.00
	George Marino	Services	10.00
12	Michaud Bros	Matches	1.10
16	Sam. V. Morris	Part pay roll, April	75.00
19	E. B. Meyrowitz	Photographic supplies	1.90
20	Oakley G. Haines	Part pay roll, April	50.00
21	Thos. F. McGlynn	Pay roll, March	6.00
30	Sundry persons	Part pay roll, April	503.50
	John Wade	Services, April	100.00
May 4	Sundry persons	Pay roll for April	318.00
	George Marino	Services	10.00
	Sundry persons	Pay roll for April	86.00
	.....do	.....do	155.00
5	.....do	.....do	105.00
	.....do	.....do	80.00
27	J. F. Barnard	Lumber	145.78
June 1	Sundry persons	Pay roll for May	157.50
4	.....do	.....do	150.19
	.....do	.....do	283.00
	.....do	.....do	134.00
	.....do	.....do	89.00
	George Marino	Services	10.00
7	Sundry persons	Pay roll, May	105.00
13	F. C. Bolin	Hauling	203.83
	Frank A. Allen	Team hire	11.00
14	W. J. & H. D. Powers	Hardware	19.77
	.....do	.....do	1.58
	John Jackson	Hay	5.00
	.....do	Team hire	11.00
	Itasca Mercantile Co	Subsistence	186.39
	L. F. Knox	Lumber	32.04
	Archibald Johnson	Traveling expenses	7.15
	.....do	.....do	6.95
	.....do	.....do	11.00
16	Sundry persons	Pay roll, June, part	155.00
21	A. D. & P. R Brooks	Hardware	.85
24	Zimmerman Bros	Photograph supplies	4.43
30	Sundry persons	Pay roll, June, part	515.00
	.....do	Pay roll, June	137.20
	Total voucher expenditures		20,249.26
	Treasury settlements during year		247.93
	Total expenditures		20,497.19

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Outstanding liabilities June 30, 1898.

To whom owing.	On account of—	Amount.
Pioneer Press Co	Printing	$15.75
Ryan Drug Co	Soap	.75
Northwestern Telephone Exchange Co	Telephone service	9.05
A. Purdy	Team hire	6.00
Sundry persons	Pay roll, June	131.20
George Marino	Services	10.00
Neil McKay	Board of employees	24.00
Pay roll	Sundry persons	326.38
John Jackson	Team hire	42.00
Frank N. Allen	do	25.00
Pay roll	Sandy Lake	155.00
Do	Leech Lake	280.00
Do	Winnibigoshish	86.00
Mike Sweeney	Fresh meat	3.00
C. H. Marr	Freight	63.27
B. C. Finnegan	Meals	4.00
John Jackson	Hay	7.50
Archibald Johnson	Traveling expenses	8.15
George Lydick	Hauling	10.00
Western Union Telegraph Co	Telegrams	6.28
Railroads	Unsettled freight accounts outstanding.	550.00
Total		1,763.33
Expended to June 30, 1898		20,497.19

A A 4.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

REFERENCE TO PAST REPORTS.

For preliminary examination and project, see Annual Report Chief of Engineers for 1868, page 306. For project for wing dams, see Annual Report, 1875, page 379; 1876, page 707; 1877, page 574; 1878, page 729; 1879, page 1169. For revetting banks, see report for 1879, page 1172. For full description and statement of revisions of projects, see Annual Report, 1895, page 2183.

WORK OF PAST YEAR.

During the fall months repairs were made to a few dams. During the winter stone was quarried and delivered near the sites of the dams to be worked on during the summer of 1898. For detailed information reference should be made to the appended report of my assistant engineer, Mr. R. Davenport.

Total expenditures, excluding outstanding liabilities, to June 30, 1897, $183,884.57.
Total expenditures, excluding outstanding liabilities, during fiscal year ending June 30, 1898, $4,030.95.
Outstanding liabilties on June 30, 1898, $792.44.

The expense properly chargeable to fiscal year ending June 30, 1898, has been distributed as follows:

Superintendence, general contingencies, and St. Paul office	$1,190.38
Plant and care of property	812.22
Repair of Eau Galle Dam	570.00
Construction of dam at Dead Lake	905.69
General work	552.66
Total	4,030.95

The work is in the collection district of Milwaukee, Wis.

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Money statement.

July 1, 1897, balance unexpended	$7,890.43
June 30, 1898, amount expended during fiscal year	4,030.95
July 1, 1898, balance unexpended	3,859.48
July 1, 1898, outstanding liabilities	792.44
July 1, 1898, balance available	3,067.04
Amount (estimated) required for completion of existing project	80,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1900	80,737.72

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Of August 11, 1886	$10,000
Approved June 8, 1878	10,000	Approved September 19, 1890	10,000
Approved March 2, 1879	8,000	Approved July 13, 1892	5,000
Approved June 14, 1880	10,000	Of August 18, 1894	10,000
Approved March 3, 1881	10,000	Passed June 3, 1896	10,000
Passed August 2, 1882	65,000		
Approved July 5, 1884	15,000	Total	191,750
Approved August 5, 1886	18,750		

COMMERCIAL STATISTICS.

Comparative statement of lumber, laths, shingles, pickets, and logs.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total tonnage, exclusive of loose logs.	Loose logs.
	Feet B. M.	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet B. M.*
1878	154,119,860	40,000,000	125,000,000	10,000,000	.....	Unknown.
1879	248,932,000	62,044,000	135,152,000	12,000,000	.....	250,000,000
1880	325,150,000	100,357,750	74,945,150	2,423,940	.....	300,000,000
1881	342,887,000	64,787,000	121,437,000	1,880,000	.....	300,000,000
1882	375,000,000	66,000,000	150,000,000	2,200,000	.....	350,000,000
1883	269,094,203	82,643,500	129,754,000	1,497,948	.....	450,000,000
1884	298,344,591	88,905,520	160,133,000	1,840,278	.....	534,674,176
1885	374,138,443	95,992,900	195,880,220	75,000,000	.....	600,000,000
1886	207,205,672	77,729,630	158,465,750	1,934,340	.....	465,000,000
1887	186,826,521	64,725,580	130,516,200	3,023,235	.....	404,302,650
1888	161,309,512	50,544,370	86,348,900	1,500,320	325,971	542,437,000
1889	158,938,294	50,487,355	112,053,075	2,244,786	329,156	400,518,720
1890	166,477,966	46,234,673	78,499,500	1,222,989	342,350	606,992,790
1891	152,040,386	107,841,850	48,700,210	1,258,850	314,085	284,113,430
1892	144,651,150	46,451,170	109,356,000	1,507,050	410,960	632,350,670
1893	159,180,534	43,938,210	108,774,500	1,940,525	459,505	488,926,000
1894	128,703,908	33,550,370	74,183,250	1,420,618	333,157	250,045,730
1895	130,117,213	29,928,099	69,718,000	581,705	327,550	292,640,000
1896	104,715,810	28,952,430	50,814,000	340,184	258,776	297,391,000
1897	98,394,313	25,180,030	54,680,000	383,449	250,089	203,598,960

Comparative statement of freight and passengers.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
		Pounds.				*Pounds.*	
1878	4	Unknown.	Unknown.	1882	3	2,640,000	10,490
1879	4	6,840,000	8,730	1883	3	3,184,000	4,000
1880	4	3,440,000	11,240	1884	2	1,500,000	5,500
1881	3	3,932,000	16,989	1885 to 1896	a1	.....	.....

a One hundred and eight tons burden and 2 feet draft.

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But one steamboat plied regularly on the river since 1885. This boat, the *Phil Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunville, about halfway between the mouth and Eau Claire, to assist The Knapp, Stout & Co. Company's rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., June 30, 1898.

CAPTAIN: The following report of operations on the Chippewa River, Wisconsin, during the fiscal year ending June 30, 1898, is respectfully submitted:

Work on the river in 1897 was confined entirely to the repair of the dams at Plum Island; Dam No. 1, repaired and raised for about 40 feet in length, and Dam No. 2, repaired and raised for about 150 feet in length. Material used, brush fascines, 80 cords; riprap stone, 25 cords. Cost of completed work, stone and brush in place, $4.68\frac{1}{2}$ per cord.

Commencing in February, 1898, two barges, length 50 feet, width 14 feet, depth 3 feet 6 inches, were built for the Chippewa River work at St. Paul Park, Minn. The boats were completed and launched in May. The material used in the construction of the boats was Washington fir. Cost in detail: Lumber, 24,860 feet B. M., $369.05; labor, $406.28; iron, boat spikes, etc., $62.62; paint, etc., $6.45; rent of boat yard, $10. Total cost for the two barges, $854.40.

On the river this season operations have been confined so far to the collection of material for the repair of Eau Galle Dam—105 cords of riprap stone, at $5.25 per cord delivered, and 200 cords of brush fascines now under contract, at 92 cents per cord; and the construction of a brush and stone dam at Dead Lake Bar—201.1 cords of riprap stone, at $4.49 per cord delivered, 600 cords of brush fascines under contract for delivery, at 97 cents per cord. This work is proposed to be commenced in July, as soon as the material now under contract is delivered and the river is at a favorable working stage.

Mr. A. O. Powell, assistant engineer, was in charge of the field operations on this work until November 18, 1897.

Very respectfully, your obedient servant,

R. DAVENPORT, *Assistant Engineer.*

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

A A 5.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

REFERENCE TO PAST REPORTS.

For project, see Annual Report of the Chief of Engineers for 1897, page 2154. This also gives a history of the work, and of the changes in estimates, including Congressional action relative to improvement at Stillwater Harbor.

WORK OF PAST YEAR.

A few dams were repaired, and a small pump dredge was built for about $5,000 to dredge in Stillwater Harbor.

For details reference should be made to the appended report of Mr. R. Davenport, assistant engineer.

Total expenditures, excluding outstanding liabilities, to June 30, 1897, $114,687.19.
Total expenditures, excluding outstanding liabilities, during fiscal year ending June 30, 1898, $7,467.89.
Outstanding liabilities June 30, 1898, $1,293.68.

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The expense properly chargeable to fiscal year ending June 30, 1898, has been distributed as follows:

Superintendence, general contingencies, and St. Paul office	$1,277.51
General work	1,103.15
Construction of dredge	5,087.23
Total	7,467.89

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport.

Money statement.

July 1, 1897, balance unexpended	$12,812.81
June 30, 1898, amount expended during fiscal year	7,467.89
July 1, 1898, balance unexpended	5,344.92
July 1, 1898, outstanding liabilities	1,293.68
July 1, 1898, balance available	4,051.24
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	9,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations.

By act—		By act—	
Approved June 18, 1878	$10,000	Of August 11, 1888	$10,000
Approved March 3, 1879	8,000	Approved September 19, 1890	8,000
Approved June 14, 1880	10,000	Approved July 13, 1892	8,000
Approved March 3, 1881	8,000	Of August 18, 1894	4,000
Passed August 2, 1882	30,000	Passed June 3, 1896	15,000
Approved July 5, 1884	9,000		
Approved August 5, 1886	7,500	Total	127,500

COMMERCIAL STATISTICS.

Comparative statement of steamboats and barges, freight and passengers carried, and lumber and logs towed and rafted on the St. Croix River, Wisconsin and Minnesota.

STEAMBOATS AND BARGES.

Year.	Freight and passenger business.		Steamboats in towing and rafting business.	Year.	Freight and passenger business.		Steamboats in towing and rafting business.
	Steamboats.	Barges.			Steamboats.	Barges.	
1878	3	.....	8	1888	1	3	58
1879	3	.....	12	1889	1	1	52
1880	3	.....	29	1890	a 2	3	126
1881	2	.....	40	1891	1	.....	b 130
1882	3	24	77	1892	.....	.....	b 122
1883	3	25	51	1893	.....	.....	b 127
1884	3	25	30	1894	a 1	2	b 69
1885	4	33	50	1895	.....	.....	(c)
1886	6	38	49	1896	.....	.....	b 60
1887	3	40	58	1897	.....	.....	b 60

a One hundred and seventeen tons burden and 18 inches draft.
b From 35 to 240 tons burden and 2½ to 3½ feet draft.
c Unknown.

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Comparative statement of steamboats and barges, freight and passengers carried, etc., on the St. Croix River, Wisconsin and Minnesota—Continued.

FREIGHT AND PASSENGERS.

Year.	Freight carried.			Passengers carried.	Year.	Freight carried.			Passengers carried.
	Lumber.	Wood.	Total.			Lumber.	Wood.	Total.	
	Tons.	*Tons.*	*Tons.*			*Tons.*	*Tons.*	*Tons.*	
1878	(a)	(a)	16,000	15,000	1887	(a)	(a)	28,500	9,872
1879	(a)	(a)	23,893	9,244	1888	5,200	4,354	90,554	(a)
1880	(a)	(a)	(a)	(a)	1889	5,900	4,100	10,000	(a)
1881	(a)	(a)	17,500	11,015	1890	7,139	5,796	b13,144	921
1882	(a)	(a)	30,000	10,300	1891	100	200	300	551
1883	(a)	(a)	31,500	12,800	1894	3,205	(c)	3,205	(c)
1884	(a)	(a)	40,000	4,000	1895	(c)	(c)	(c)	(c)
1885	(a)	(a)	42,500	10,647	1896	(c)	(c)	(c)	(c)
1886	(a)	(a)	90,450	12,756	1897				14,000

a Unknown. b Including 209 tons of general merchandise. c None.

RAFTED LOGS AND LUMBER.

Year.	Rafted logs towed out of St. Croix River (estimated).	Rafted lumber towed out of St. Croix River.				Total tonnage, exclusive of loose logs.	Loose logs run on river above Stillwater.	
		Lumber.	Shingles.	Laths.	Pickets.		Feet B. M.	Tons.
	Feet B. M.	*Feet B. M.*	*Number.*	*Number.*	*Number.*	*Tons.*		
1878	70,000,000							
1879	117,000,000							
1880	200,000,000							
1881	185,000,000							
1882	130,000,000							
1883	108,000,000							
1884	175,000,000							
1885	150,000,000							
1886	115,000,000							
1887	175,000,000	a100,000,000						
1888	136,000,000	114,610,966	a40,079,500	a23,651,800	a570,820	a706,367		
1889	150,000,000	81,817,070	38,633,000	23,226,575	90,800	697,244		
1890	250,000,000	116,403,000	46,007,000	33,861,900	278,580	1,104,100	a460,000,000	a1,610,000
1891	209,233,490	110,934,084	32,016,750	31,132,350	678,240	948,757	315,231,300	1,103,310
1892	250,000,000	126,503,520	51,959,000	37,337,200	261,040	1,179,549	436,899,770	1,529,149
1893	160,000,000	63,564,209	23,196,500	18,413,720	118,580	707,745	359,468,740	1,358,141
1894	150,000,000	105,912,803	38,861,250	28,385,600	1,059,420	805,838	281,470,400	985,146
1895	213,000,000	133,893,315	22,521,250	33,733,935	340,095	1,021,884	373,062,850	1,305,720
1896	168,300,000	67,689,498	7,893,750	16,951,700	40,000	724,204	321,764,530	1,126,176
1897	179,228,000	70,699,400	23,371,500	23,836,050	180,400	815,848	311,084,370	1,088,794

a Unknown previous years.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., June 30, 1898.

CAPTAIN: The following report of operations on the improvement of the St. Croix River, Wisconsin and Minnesota, during the fiscal year ending June 30, 1898, is respectfully submitted:

The work on the river during the last half of the season of 1897 was between Stillwater and Taylors Falls, and consisted of the removal of snags, etc., from the channel in the vicinity of Taylors Falls, and of the repair of brush and stone dams on the river below, as follows:

Deadheads and snags removed from channel at Taylors Falls			250
Rock removed from channel at Osceola		cubic yards	10
Leaning trees cut and removed			2
Repaired Folsom Island Dam, No. 3	using	37 cords brush and	30 cords stone
Repaired Folsom Island Dam, No. 2	using	13 cords brush and	10 cords stone
Repaired Sweesys Dam, No. 1	using	15 cords brush and	42 cords stone
Repaired Lime Kiln Dam, No. 1	using	5 cords brush and	10 cords stone
Repaired Pine Island Dam, No. 1	using	15 cords brush and	37 cords stone
Repaired Pine Island Dam, No. 2	using	25 cords brush and	32 cords stone
Total material		110 cords brush and	161 cords stone

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The brush and stone was collected by the crew in the vicinity of the work. The cost of the material, stone and brush, in the work was $2.66 per cord.

Season of 1898: Early in February, 1898, the work of constructing a 6-inch hydraulic dredge for the St. Croix River at Stillwater was commenced at St. Paul Park, Minn. The dredge was completed in May. The dimensions of the dredge are as follows: Hull, length, 80 feet; width, 22 feet; depth, 5 feet. The material used was mainly Washington fir. The machinery, on a flush deck, is covered by a deck house 57 feet long, 12 feet wide forward, 18 feet wide aft. Above the deck house is a small cabin, used for kitchen, dining room, and office, 28 feet long by 12 feet wide. Bunk rooms are provided for crew of 8 men on the main deck. The dredge is fitted with the following machinery: One 40-horsepower boiler; 1 hoisting shaft, with 15-horsepower engine, fitted with spud hoist drums, rope spools, hoisting drum for agitator, etc.; 1 steam force pump for boiler feed, water jet, fire purposes, etc.; one 6-inch hydraulic pump and engine; 1 agitator with 15-horsepower engine. The dredge is supplied with 50 feet of suction pipe and 300 feet of conveyor pipe.

The cost of the dredge, completed, was $5,041.33, divided as follows: Machinery, $2,826.19; lumber, $810.83; labor, $1,129.77; iron, boat spikes, etc., $146.28; oakum, $31.25; hardware, $15.38; paint, $17.88; roofing material, $33; blacksmith coal, $15.75; rental of boat yard, $15.

Forty-seven thousand six hundred and forty-five feet B. M. of lumber, mainly Washington fir, was used in the construction of the boat.

Four barges, of an average length of 48 feet and width of 12 feet, were purchased and repaired for a conveyor-pipe support, at a cost of $135.

After the completion of the work at St. Paul Park, the dredging fleet was removed to Stillwater, Minn., where the machinery is now being tested and prepared for the regular work. Operations so far have, however, been materially interfered with by a very high stage of water on the St. Croix River at that point.

Very respectfully, your obedient servant,

R. DAVENPORT, *Assistant Engineer.*

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

A A 6.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

The commerce of the territory lying adjacent to this river is mostly carried by the railroads along its course, and no increase of boat traffic has followed the work done for improving the navigable depth. As the balance of the last appropriation was only $2.35, authority was asked and obtained to drop this river from the list of works in my charge. The balance was turned into the Treasury, and no further reports will be submitted unless the project is revived by further appropriations.

Amount expended to June 30, 1897, on all parts of the river, $131,370.45.

Amount expended during fiscal year ending June 30, 1898, $127.20.

Money statement.

July 1, 1897, balance unexpended	$129.55
June 30, 1898, amount expended during fiscal year	127.20
Returned to the Treasury of the United States	2.35

Abstract of appropriations.

By act—		By act—	
Approved March 3, 1867	$87,500	Approved August 14, 1876	$10,000
Approved July 11, 1870	10,000	Approved June 18, 1878	10,000
Approved March 3, 1871	10,000	Of August 11, 1888	10,000
Approved June 10, 1872	10,000	Passed June 3, 1896	4,000
Passed March 3, 1873	10,000		
Approved June 23, 1874	10,000	Total	*131,500
Approved March 3, 1875	10,000		

*Of this amount, $2.35 was, in June, 1898, deposited in the Treasury of the United States.

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A A 7.

IMPROVEMENT OF THE RED RIVER OF THE NORTH, MINNESOTA, AND DAKOTA.

REFERENCE TO PAST REPORTS.

For physical characteristics, see Annual Report of Chief of Engineers, for 1874, p. 295; 1875, p. 370; 1878, p. 730; 1879, p. 1192. For plans of improvement, see Report for 1874, p. 297; 1879, p. 1191; 1881, p. 1757. Revisions of project, 1883, p. 1450; 1887, p. 1712.

WORK OF PAST YEAR.

Dredging has been done near Goose Rapids and north of Grand Forks, by hired labor, at a cost of 21 cents per cubic yard. The plant is out of repair, and this has increased the cost about one-quarter.

The Northern Pacific Railway has caused a large land slide, which seriously obstructs the river close to Grand Forks, by attempting to raise their embankment too high. The matter is now in the hands of the Department of Justice for prosecution of the company, as they have refused to take any steps to abate the trouble. Important details of this matter are given in the appended report of the assistant engineer in local charge, Mr. R. Davenport.

The plant is in urgent need of repairs. See Annual Report of the Chief of Engineers, for 1897, page 2162.

Total expenditures, excluding outstanding liabilities, to June 30, 1897, $265,369.90.
Total expenditures, excluding outstanding liabilities, for fiscal year ending June 30, 1898, $6,174.01.
Outstanding liabilities on June 30, 1898, $115.

Expense properly chargeable to fiscal year ending June 30, 1898, has been distributed as follows:

Superintendence, contingencies, and St. Paul office	$2,065.60
Dredging	1,996.41
Steamboat	1,546.96
Care of property, etc	565.04
Total	6,174.01

RED LAKE RIVER.

This river is under improvement as part of the Red River of the North, in accordance with the river and harbor act of June 3, 1896. It formed no part of the original project for the Red River of the North, and has never been accurately surveyed. No properly considered project for its improvement is possible without such a survey, and no reliable estimate of the cost of the improvement exists.

REFERENCE TO PAST REPORTS.

In the Annual Report of the Chief of Engineers for 1887, p. 1724, Major Allen estimated the cost of a survey at $30,000 and did not think the river worthy of improvement at that time. In the Annual Report of 1895, p. 2211, Lieutenant-Colonel Jones recommended the improvement. Beyond clearing the river of bowlders and logs, nothing should be done till an accurate survey and estimate of cost is available. Five thousand dollars would probably be enough to complete the rough clearing of the river from Red Lake to Thief River Falls.

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WORK OF PAST YEAR.

The river was roughly cleared of bowlders and snags for 35 miles. The bowlders cost about $1.10 each per cubic yard. The snags about 50 cents apiece.

Total expenditures, excluding outstanding liabilities, to June 30, 1897, $2,576.63.
Total expenditures, excluding liabilities outstanding, during fiscal year ending June 30, 1898, $2,351.79.
Outstanding liabilities on June 30, 1898, $71.58.

The expense properly chargeable to fiscal year ending June 30, 1898, has been distributed as follows:

Superintendence, contingencies, and St. Paul office	$835.11
Care of property	374.33
Work	1,137.05
Plant	5.30
Total	2,351.79

The work is in the collection district of St. Paul, Minn., of which St. Vincent is a subport of entry.

Money statement.

July 1, 1897, balance unexpended	$10,348.78
Refund, overpayment	5.00
	10,353.78
June 30, 1898, amount expended during fiscal year	8,530.80
July 1, 1898, balance unexpended	1,822.98
July 1, 1898, outstanding liabilities	186.58
July 1, 1898, balance available	1,636.40
Amount (estimated) required for completion of existing project	37,320.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	37,320.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Of August 11, 1888	$20,000
Approved June 18, 1878	30,000	Approved September 19, 1890	25,000
Approved March 3, 1879	25,000	Approved July 13, 1892	25,000
Approved June 14, 1880	20,000	Of August 18, 1894	15,000
Approved March 3, 1881	18,000	Passed June 3, 1896	20,000
Passed August 2, 1882	10,000	Total	273,000
Approved July 5, 1884	10,000		
Approved August 5, 1886	50,000		

COMMERCIAL STATISTICS.

RED RIVER OF THE NORTH.

The stage of water in the Red River during the season of 1897 was very favorable for steamboat operation, the range at the Grand Forks gauge being from +45.3 feet in April to +2.2 in November, with at no time less than 5.7 feet of water in the channel.

Steamboat navigation commenced April 13 and closed November 11. The boats operated on the Red River were the Red River Transportation Company's steamer

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Grand Forks, 100 tons, with three barges of 27 tons each, and the gasoline boat *City of Grand Forks*, 12 tons, with three barges of 40 tons each.

The following is a statement of the freight moved by the boats during the season of 1897:

Red River Transportation Company's steamer *Grand Forks* and three barges:		
To Grand Forks from points north and south—		
Wheat	tons..	6,520.6
Wood	do...	3,337.5
From Grand Forks to points north and south—		
Merchandise	do...	59
Lumber	do...	178.3
Gasoline boat *City of Grand Forks* and three barges:		
To Grand Forks from points north and south—		
Wheat	do...	1,944
Wood	do...	675
From Grand Forks to points north and south—		
Merchandise	do...	19.9
Lumber	do...	91.9
Farm machinery	do...	1,014
Total	do...	13,840.2

RED LAKE RIVER.

The stage of water in Red Lake River during the season of 1897 was very favorable for steamboat operations. With the worst bowlders removed from the rapids above Thief River Falls, there was at no time less than 3 feet of water in the channel.

Boats operated on the river were the *Alice Meehan*, 50 tons, Meehan Brothers; *Viking*, 50 tons, Everson & Bro.; *Red Lake Express*, 50 tons, H. L. Hanson & Co., all of Thief River Falls, Minn.

Boats operated on Red Lake: *Jas. Meehan*, 150 tons, Meehan Brothers; *Martin Lally*, 150 tons, T. B. Walker, Minneapolis, Minn.

Season of 1897.

Steamer *Alice Meehan:*		
Freight (Thief River Falls to Red Lake)	tons..	240
Passengers		281
Trips made		50
Steamer *Viking:*		
Freight (Thief River Falls to Red Lake)	tons..	102
Passengers		120
Trips made		5
Steamer *Red Lake Express:*		
Freight (Thief River Falls to Red Lake)	tons..	300
Passengers		500
Trips made		64
Steamer *James Meehan:*		
Logs towed in Red Lake	feet B. M..	15,000,000
Steamer *Martin Lally:*		
Logs towed in Red Lake	do....	6,000,000

Lumber manufactured at Thief River Falls, Minn., 1897, 1,500,000 feet B. M. Twenty-two million feet B. M. of logs passed Thief River Falls during the season of 1897. These logs were for the sawmills at St. Hillaire, Red Lake Falls, and Crookston.

Comparative statement of freight, etc., moved by steamboats during the past three years.

	Freight.	Passengers.	Trips made.	Run of logs (feet B.M.).
	Tons.			
1897	642	901	119	22,000,000
1896	198	714	52	20,000,000
1895	145.5	281	35	15,000,000

Estimated log cut on Red Lake for season of 1897–1898, 40,000,000 feet B. M.

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REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., June 30, 1898.

CAPTAIN: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1898, is respectfully submitted:

GENERAL IMPROVEMENT.

Season of 1897.—Dredging operations, having been commenced earlier in the season, were continued on Goose Rapids, redredging and extending some of the old channel cuttings, and was carried on until July 22, when a sudden rise in the river, bringing the water up to 17.3 feet on that date, brought dredging operations to a temporary close. The flood reached a height of 27 feet on the Goose Rapids gauge and 24.5 feet on the Grand Forks gauge on the 28th of July, after which date the water receded slowly. While waiting for the water to fall the crews of the dredge and steamboat were occupied with general repair work on the boats, on the dredge, on the hull and machinery, and on the steamboat in placing, painting, and sanding a new canvas roof on the boiler deck, and in generally repairing and painting the boat.

On August 6, the water having fallen to a working stage, 13.8 feet on the Grand Forks gauge, dredging was commenced on the bars to the north of Grand Forks, the fleet in the meantime having been moved to that locality from Goose Rapids. The work north of Grand Forks, dredging new bars and clearing and extending old channel cuttings, was carried on until September 7, when the work was ordered closed and the fleet to be returned and laid up at Grand Forks.

Length of river worked over on Goose Rapids, 2¼ miles; number of channel cuttings, 4; total excavation, 7,715 cubic yards; length of channel cuttings, 2,850 linear feet; training dams formed of the excavated material, 2,850 linear feet.

The steamer *Ogama*, operating in connection with the dredge on Goose Rapids, towing the fleet, wood barges, etc., made 9 trips. Total miles run, 357. Wood loaded, 53½ cords.

Steamer *Ogama*, operated as a snag boat on the Goose Rapids section of the river, removed 73 overhanging trees 4 to 14 inches in diameter, 1 pile 16 inches in diameter, and 1 bowlder, one-fourth cubic yard.

Length of river worked over by the dredge north of Grand Forks, 6¾ miles; number of channel cuttings, 6; total excavation, 11,096 cubic yards; length of channel cuttings, 3,400 linear feet; training dams formed with the excavated material, 3,400 linear feet.

Steamer *Ogama*, operating in connection with the dredge on the river north of Grand Forks, made 21 trips. Total miles run, 386. Wood loaded, 51½ cords.

General summary.

ON GOOSE RAPIDS.

Location.	Number of cut.	Excavation.	Channel cut.	Training dams.	Miles river worked over.
		Cu. yds.	*Lin. ft.*	*Lin. ft.*	
Sec. 1, T. 147, R. 49	2	3,585	1,150	1,150	¾
Sec. 36, T. 148, R. 49	3	1,062	350	350	1
Do	4	2,006	900	900	¼
Sec. 35, T. 148, R. 49	5	1,062	450	450	¼
Total		7,715	2,850	2,850	2¼

NORTH OF GRAND FORKS.

Sec. 10, T. 152, R. 50	1	1,129	350	350	
Sec. 3, T. 152, R. 50	2	1,948	620	620	2
Sec. 34, T. 153, R. 50	3	900	275	275	1
Sec. 22, T. 153, R. 50	4	2,948	1,030	1,030	2
Sec. 16, T. 153, R. 50	5	1,929	600	600	1¾
Sec. 16, T. 153, R. 50	6	2,242	525	525	
Total		11,096	3,400	3,400	6¾

Trips made by steamboat, 30; total miles run, 743; wood loaded, 105 cords. Obstructions removed: Overhanging trees, 73; pile, 16 inches diameter, 1; bowlder, one-fourth cubic yard.

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Cost of dredging, 20.8 cents per cubic yard; cost of subsistence, per ration, 36.4 cents. The cost of running the steamer *Ogama* in connection with the dredge is included in the cost of the work.

The cost of dredging per cubic yard this year was about 25 per cent more than the general average up to this time. This was caused in part by high stages of water that retarded the dredging, but mainly on account of the extreme care necessary in handling the dredge, owing to the badly decayed condition of the hull and A braces. In this connection, attention is respectfully called to the estimate of cost of repairing the dredging fleet, pages 2162–2165, Appendix Y, Annual Report of Chief of Engineers for 1897.

All of the work done in 1897 was on portions of the river previously worked over by the dredge, the necessity for redredging being caused by landslides. A landslide in the river that is liable to give much trouble is that caused by the raising of the track embankment of the Northern Pacific Railway in a concave bend of the river at Grand Forks, N. Dak. This embankment caused settlement of the material along the river bank some years ago, when first built, forcing the bottom of the river up an average of about 2 feet for some 500 feet in length and for about one-third of the width of the river. When, however, the filling was discontinued at that time there was no further disturbance. An attempt to bring this embankment up to grade in 1897, 12 to 14 feet additional being required, caused more material to be forced into the river, and a bar was formed about 500 feet long, occupying about one-half the width of the river, the material, mainly clay, being forced up above the original level of the river bottom from 4 to 8 feet. At this time the steamboat channel on the opposite side of the river was narrowed down to a width of about 60 feet, with a low-water depth of about 4 feet, where formerly there was a low-water depth of from 6 to 8 feet. As soon as work was discontinued on the embankment last season the disturbance of the river bottom ceased. Work on this embankment was resumed this spring, and was followed almost immediately by movement in the bottom of the river.

Season of 1898.—Other than care of boats and property, no work has been done on the Red River of the North during the first half of the season of 1898.

RED LAKE RIVER.

Season of 1897.—The preparation of the derrick fleet for the continuation of the improvement of Red Lake River on account of extreme high water was not commenced until July 1, 1897. The fleet was towed up river and the work of removing obstructions from the channel and banks of the river was commenced July 3. The improvement was carried on until the 10th of September, when the work was ordered to be closed and the fleet returned and laid up at Thief River Falls.

Length of river worked over, 35 miles. Obstructions removed: Bowlders, 1,685, 665$\frac{1}{27}$ cubic yards; overhanging trees, 4 to 34 inches diameter, 1,365; snags, 4 to 34 inches diameter, 151; stumps, 4 to 30 inches diameter, 141.

Average cost of work: Bowlders, 1.06\frac{3}{4}$ per cubic yard; overhanging trees, snags, and stumps, 46 cents each. Cost of subsistence, per ration, 38.1 cents. The bowlders removed from the channel range from small stones of one-half cubic foot up to bowlders containing 200 cubic feet.

On the section of river worked over probably one full season's more work will be required to complete the improvement. The entire section was worked over, however, with a view of removing the worst obstructions, so that it might be made as uniformly good as the limited time would permit.

Very respectfully, your obedient servant,

R. DAVENPORT, *Assistant Engineer.*

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

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GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

A number of staff gauges were set along the river between Minneapolis and St. Paul, and these were read daily after April 15, 1898. These staff-gauge readings are tabulated, as they have considerable value in determining the variations in slope with the different stages of the river. The zero of each gauge is Cairo datum. Cairo datum is approximately 21.26 feet below mean gulf level at Biloxi, Miss.

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Valuable tables, showing the relation of the rainfall to run-off in the Mississippi Valley above St. Paul, are printed on page 2169, Annual Report Chief of Engineers for 1897.

Amount expended to June 30, 1897, $4,900.
Amount expended during fiscal year ending June 30, 1898, $500.
Amount expended to June 30, 1898, $5,400.

Money statement.

Amount allotted for the fiscal year ending June 30, 1898	$500.00
June 30, 1898, amount expended during the fiscal year	500.00

Abstract of allotments.

For fiscal year ending June 30—		For fiscal year ending June 30—	
1889	*$900	1894	$500
1890	600	1895	500
1891	900	1896	500
1892	900	1897	500
1893	500	1898	500

Stages of Mississippi River, between Minneapolis and St. Paul, Minn.

[NOTE.—The zero of gauges is Cairo datum, which is approximately 21.26 feet below mean Gulf level at Biloxi, Miss.]

Date.	Belt Line Bridge.	Washington Avenue Bridge.	Riverside Park.	Franklin Avenue Bridge.	Dennoyer Park, site of Lock and Dam No. 2.	Marshall Avenue Bridge.	Groveland Park.	Soldiers' Home.	Fort Snelling Bridge.	Mouth of Minnesota River (below dam).	Chicago, St. Paul, Minneapolis and Omaha Railway Bridge.	Foot of Jackson street.
1898.												
April 15	.....	740.7	737.4	732.5	726.9	722.9	.....	.....	.....	.....	.....	.....
16	.....	40.8	37.5	32.5	26.9	23	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	40.8	37.5	32.5	26.9	22.9	.....	.....	.....	.....	.....	.....
19	753.3	40.7	37.4	32.4	26.8	22.9	.....	.....	.....	.....	.....	.....
20	53.3	40.6	37.3	32.3	26.8	22.9	.....	.....	.....	.....	.....	.....
21	53.2	40.5	37.1	32.2	26.6	.....	719.6	716	713.1	.....	.....	.....
22	52.7	40.4	37	32.1	26.6	.....	19.6	15.9	12.9	.....	708.8	708.1
23	52.8	40.3	36.9	32	26.5	.....	19.6	15.9	12.8	.....	8.7	8.1
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	53.1	40.5	37.1	32.2	26.6	.....	19.6	16	12.8	710.2	8.6	7.9
26	52.7	.....	36.6	31.6	.....	22.1	.....	15.6	.....	9.7	8.4	.....
27	52.7	.....	36.8	31.9	26.4	22.4	19.4	15.8	12.6	9.8	8.7	7.8
28	52.6	.....	36.8	31.8	26.4	22.3	19.3	15.7	12.6	9.8	8.6	7.7
29	52.7	40.1	36.8	31.9	26.4	22.3	19.4	15.7	12.6	9.8	8.6	7.6
30	52.9	40.2	36.9	32	26.5	22.4	19.5	15.9	12.6	9.8	8.7	7.7
May 1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	753.1	740.4	737.1	732.1	726.6	722.6	719.6	716.1	712.9	710.2	709	707.9
3	53.1	40.4	37.1	32.1	26.6	22.6	19.6	16.1	12.9	10.3	9	8
4	53.3	40.6	37.3	32.3	26.7	.....	19.8	16.2	13.1	10.4	9.2	8.2
5	53.3	40.6	37.3	32.3	26.8	.....	19.8	16.3	13.1	10.5	9.2	8.2
6	53.4	40.6	37.3	32.3	26.8	.....	19.8	16.3	13.1	10.5	9.3	8.3
7	53.3	40.6	37.3	32.3	26.7	.....	19.8	16.3	13.1	10.4	9.2	8.2
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	53.2	40.4	37.2	32.2	26.6	22.7	19.7	16.1	12.9	10.2	9	8
10	52.9	40.3	37	32	26.5	22.5	19.5	16	12.7	10	8.8	7.7
11	52.9	40.3	37	32	26.5	22.5	19.5	15.9	12.6	9.9	8.7	7.6
12	52.8	40.2	36.9	31.9	26.4	22.4	19.4	15.9	12.6	9.8	8.6	7.6
13	52.9	40.3	37	32	26.5	22.5	19.5	15.9	12.6	9.8	8.6	7.6
14	52.9	40.3	37	32	26.5	22.5	19.5	15.9	12.6	9.9	8.7	7.7
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	53.2	40.5	37.2	32.2	26.7	22.7	19.7	16.1	12.7	10	8.8	7.7
17	53	40.3	37	32	26.5	22.5	19.5	16	12.6	9.9	8.7	7.6
18	53	40.3	37	32	26.5	22.6	19.5	16	12.7	9.9	8.7	7.7
19	53.1	40.4	37.1	32.1	26.6	22.6	19.6	16.1	12.7	10	8.8	7.7

* Not used.

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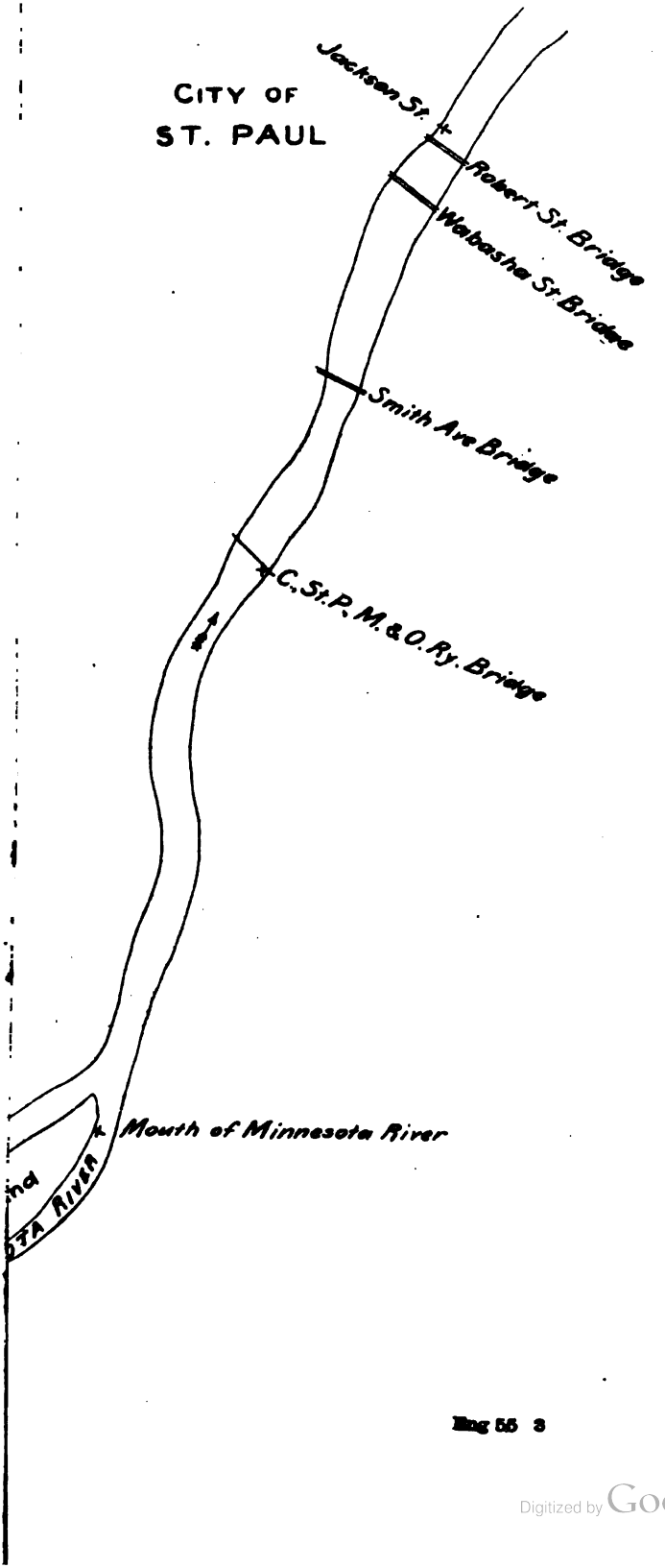

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Stages of Mississippi River, between Minneapolis and St. Paul, Minn.—Continued.

Date.	Belt Line Bridge.	Washington Avenue Bridge.	Riverside Park.	Franklin Avenue Bridge.	Desnoyer Park, site of Lock and Dam No. 2.	Marshall Avenue Bridge.	Groveland Park.	Soldiers' Home.	Fort Snelling Bridge.	Mouth of Minnesota River (below dam).	Chicago, St. Paul, Minneapolis and Omaha Railway Bridge.	Foot of Jackson street.
1898.												
May 20	53.2	40.5	37.3	32.3	26.7	22.8	19.7	16.2	12.8	10.1	8.9	7.9
21	53.3	40.6	37.3	32.3	26.7	22.8	19.8	16.3	13	10.4	9.1	8.1
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	53.9	41.1	37.7	32.8	27.2	23.3	20.3	16.9	13.8	11.2	9.8	8.9
24	54	41.1	37.8	32.9	27.2	23.3	20.4	17	14	11.5	10	9.1
25	54	41.1	37.8	32.9	27.3	23.4	20.4	17	14.1	11.6	10.1	9.2
26	53.9	41	37.7	32.8	27.2	23.3	20.3	16.9	13.9	11.4	10	9.1
27	53.8	41.1	37.7	32.9	27.3	23.4	20.5	17.1	14.1	11.7	10.2	9.3
28	54	41.3	37.9	33	27.4	23.5	20.6	17.2	14.2	11.9	10.3	9.4
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	54.4	41.6	38.1	33.3	27.7	23.8	21	17.6	14.7	12.3	10.7	9.8
June 1	754.4	741.6	738.1	733.3	727.6	723.8	720.9	717.5	714.6	712.3	710.6	709.7
2	54.3	41.6	38.1	33.3	27.6	23.8	20.8	17.5	14.6	12.2	10.6	9.7
3	54.3	41.5	38	33.2	27.5	23.7	20.8	17.4	14.5	12.2	10.5	9.6
4	54.2	41.6	38.1	33.3	27.6	23.8	20.9	17.5	14.6	12.3	10.6	9.7
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	57	45.5	41.9	37	31.4	28.4	26	23.2	19.4	17.8	15.2	14
7	57.5	46.3	42.1	37.4	32	29	26.7	24.1	20.4	18.9	16.3	15.1
8	57.3	46.1	42	37.3	31.9	28.9	26.6	24	20.5	19.1	16.5	15.3
9	57	46	41.9	37.1	31.6	28.6	26.3	23.7	20.4	18.9	16.4	15.2
10	56.6	45.6	41.7	36.9	31.3	28.3	25.9	23.4	20.1	18.7	16.2	15
11	56.5	45.4	41.5	36.7	31	28	25.5	22.9	19.8	18.3	15.9	14.7
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	56.4	45	41.1	36.3	30.6	27.3	24.8	22.1	19.2	17.7	15.2	14.1
14	56.3	44.7	40.8	36	30.3	27	24.4	21.7	18.8	17.3	14.8	13.8
15	56.3	44.3	40.5	35.7	29.9	26.6	23.9	21.1	18.3	16.7	14.3	13.3
16	56.1	43.9	40.1	35.3	29.6	26.1	23.4	20.5	17.7	16.1	13.8	13.2
17	55.9	43.6	39.9	.....	29.2	25.7	23	20.1	17.3	15.6	13.3	12.4
18	55.7	43.3	39.6	.....	29	25.4	22.8	19.7	17	15.2	13	12
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	55.5	42.8	39.2	.....	28.7	.....	22.3	19.2	16.4	14.4	12.4	11.4
21	55.3	42.6	39	.....	28.5	.....	22.1	18.9	16.2	14.1	12.1	11.2
22	55.1	42.4	38.8	33.8	28.3	24.6	21.8	18.6	15.5	13.8	11.8	10.9
23	55	42.2	38.6	33.7	28.1	24.4	21.6	18.4	15.6	13.5	11.5	10.6
24	54.9	42	.....	33.5	28	.....	21.5	18.2	15.4	13.1	11.3	10.4
25	54.7	41.9	.....	33.4	27.8	.....	21.2	17.9	15.2	12.8	11	10.1
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	54.6	41.8	38.3	33.3	27.7	24	21.2	17.8	15	12.5	10.8	9.9
28	54.3	41.5	38	.....	27.5	23.7	20.8	17.5	14.6	12	10.4	9.6
29	54.3	41.5	38.1	.....	27.6	23.8	20.9	17.5	14.6	12	10.5	9.6
30	54.1	41.3	37.9	33	27.4	23.6	20.7	17.4	14.4	11.7	10.2	9.4

Itemized statement of expenditures during the fiscal year ending June 30, 1898.

Date.	To whom paid.	For what paid.	Amount.
1897.			
July 26	Sundry persons	Emergency purchases	$25.54
	.....do	.....do	28.78
	Kent Nelson	Traveling expenses	7.50
	Soren Denesen	Services	4.50
Aug. 13	Kuhlo & Ellerbe	Tape	10.00
Sept. 3	James E. Auge	Services	5.00
Sept. 13	Kent Nelson	Traveling expenses	4.50
	J. J. Beaudette	Services	13.00
Sept. 24	Sundry persons	Pay roll, September	244.00
Oct. 1	.....do	.....do	61.00
Oct. 6	J. J. Beaudette	Services	13.00
	Kent Nelson	Traveling expenses	2.60
	.....do	.....do	.90
Nov. 17	W. T. Hutchins	.....do	1.50
Dec. 4	J. J. Beaudette	Services	3.90
1898.			
Feb. 4	Board of water commissioners	Water	.50
June 30	Globe Building Co	Rent	73.78
	Total		500.00

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A A 9.

SURVEY OF BIG STONE LAKE AND LAKE TRAVERSE, MINNESOTA, WITH A VIEW TO THE CONSTRUCTION OF RESERVOIRS.

[Printed in House Doc. No. 134, Fifty-fifth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 6, 1897.

SIR: The river and harbor act of June 3, 1896, provides for a survey of "Big Stone Lake and Lake Traverse [Minnesota], with a view to the construction of reservoirs, in accordance with the report of Maj. W. A. Jones, of the Engineer Corps of the United States Army, dated January sixteenth, eighteen hundred and ninety-five."

The duty of making the survey thus called for was assigned to the charge of Lieutenant-Colonel Jones, who, under date of November 15, 1897, submits a report, with plans* and estimates, which it is assumed are such plans as were contemplated in his report on preliminary examination of January 16, 1895, and the plans called for by the law.

The report is accompanied by a subreport of Mr. W. C. Weeks, who made the survey. Mr. Weeks submits certain plans for which the estimated cost is $745,965. Lieutenant-Colonel Jones modifies these plans and submits estimates of cost amounting to $350,000.

The plans and estimates presented must be considered preliminary, and should Congress decide to make provision for this work much further detailed study of the proposed work must be made.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF LIEUT. COL. W. A. JONES, CORPS OF ENGINEERS.

BALTIMORE, MD., *November 15, 1897.*

GENERAL: I have the honor to report upon the survey of Big Stone Lake, with a view to reservoirs, made in accordance with the provisions of the river and harbor act of 1896. The survey was made in the winter of 1896–97. Full details of the same are in the report of Mr. W. C. Weeks, herewith appended. It illustrates the fact that no extremity of winter weather in these latitudes need prevent the making of an excellent survey; that the time lost from extremes of weather is compensated by the facility of getting over all sorts of ground.

In making this report I am very much hampered for lack of means of reference to the record.

The object of creating a reservoir at this locality is to store the spring and flood waters of the upper Minnesota River, in order to deliver them upon the Mississippi River at and below St. Paul for the benefit and improvement of navigation during the fall and late summer of each season or the period of very low water. It is obvious, since the navi-

* Not reprinted. Printed in House Doc. No. 134, Fifty-fifth Congress, second session.

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gability of a river depends upon the quantity of water flowing therein as a principal factor, that the greater the quantity of water flowing the better will the river be in respect to its navigability. Incidentally, the creation of a reservoir at this point can be so developed as to create an excellent water line of transportation from the foot of Big Stone Lake, across the low divide at Browns Valley, into Lake Traverse and to the foot thereof, a distance of about 60 miles.

* * * * * * *

Mr. Weeks has presented a project for the creation of this reservoir, as set forth in his report. This project is only in part approved by me, and in place of it the following is submitted:

PROJECT.

Make a dike at the north end of Lake Traverse and raise the flowage line of this lake to 980.0. Make this dike as shown in the report* of Mr. Weeks.

At the south end of this lake divert the Minnesota River by a short line over which it now discharges in flood, so that it will discharge into this lake. Make a controllable opening in the diversion dam, so as to enable discharge of surplus through the old channel when desired.

Make a canal from Lake Traverse to the Minnesota River at the point A, so as to introduce it into the natural channel without deflection. A slope of about 1:40,000 will be necessary for the bottom of this canal to prevent scour, but as the fall between the two lakes will not permit this, a lock at the point A will be necessary. This lock should have bear-trap gates, so as to permit reservoir discharge over crest of lower gate. To protect the entrance to this canal from fill, one curved dike from the west side will be sufficient. Splay the canal entrance so as to reduce slope. The bottom of the upper reach of the canal would be approximately at a reference 966.0. This would enable Big Stone Lake to be drawn to 965.0 and leave a draft of 4 feet for entering the canal. Occasional dredging may be necessary at this point. From the point where the canal enters the channel of the river I would use the natural channel for the remainder of the distance, by widening and deepening as much as may be necessary to create a bottom of uniform slope and a channel of sufficient capacity. As this channel has always carried the flood discharge of the river, it is probably of sufficient dimensions now. When the flood discharge is in excess of the quantity that may be desired to send through the canal—after having filled up Lake Traverse—lead the surplus from the point of river diversion through the old river channel.

At the upper end of Big Stone Lake place a dike CD across to the contour 75.0 and extend it along up the river to junction of that contour with river bank at E. Then continue dike from opposite side by shortest line to some point F on same contour. These dikes will be low, and will avoid considerable land damages. At the lower end of Big Stone Lake make the dam as a dike behind the coulee, as shown by the line POQ, the base being at a reference of about 76.00, or 1 foot above flowage line. The lake face of this dike should be covered with a thick growth of brush. Pending the growth of the same it can be protected with riprap and floating booms. The discharge to be sent through an operating part of crib work and slide valves, arranged for an overfall discharge of any excess that can not be controlled. Divert

*Only one map printed.

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Whetstone River into Big Stone Lake through its old bed, with a cut for navigation purposes along the line of the canal shown by Mr. Weeks.

In determining the question of land damages the fact should be noted that the iron monuments on the State boundary line at the upper ends of lakes Traverse and Big Stone marked the elevation of the lake waters at time the boundary was marked. Contours through these points should determine the level below which no land damages should be paid. This point on Lake Traverse has a reference of 79.0 approximate, and on Big Stone Lake it is about 72.0. Average high water was certainly not below the planes of these two references.

ESTIMATE.

(1) Dike at north end of Lake Traverse, 9 feet wide on top; slope 1:1 on north side and 1:3 on reservoir side; macadamized roadway on top with single track and three turn-outs, macadam of broken granite 18 inches thick; roadway will keep surface compacted; riprap and floating boom and growth of smartweed on reservoir side; marsh sod and heavy growth of brush on north side:		
40,000 cubic yards embankment, at 15 cents	$6,000	
26,000 square yards riprap, at 50 cents	13,000	
Booms, 25 M, at $24	600	
Roadway, 1.7 miles	8,000	
Sod and shrubbery	2,000	
Core wall of clay puddle	17,400	
Spillway	3,000	
		$50,000
(2) Canal, 20 feet wide at bottom, 100,000 cubic yards of excavation, at 20 cents		20,000
Lock with crib walls, stone-lift wall, bear-trap gates, 30 feet wide by 130 feet long, 6-foot lift:		
Walls, 1,000 cubic yards crib, at $4	$4,000	
Gates, two, at $1,500	3,000	
Lift wall	600	
Foundation, piles spaced 6 feet, capped and floored, with sheet piles	22,400	
		30,000
(3) Pier protection, lake entrance, 600 feet long, at $20		12,000
(4) Diversion Minnesota River:		
Dam	$10,000	
Excavation	10,000	
		20,000
(5) Enlarging channel, Minnesota River below canal, 75,000 cubic yards, at 20 cents		15,000
(6) Dikes, north end Big Stone Lake, 8,000 feet in length, at $1		8,000
(7) Dam below coulee, 5,700 feet long, 9 feet wide on top; slope 1:1 on south side and 1:3 on reservoir side; macadamized roadway on top, single track, with three turnouts; macadam of broken granite 18 inches thick; riprap, floating boom and growth of smartweed on reservoir side; marsh sod and heavy growth of brush on south side; operating part of crib work and slide valves, with spillway over crest		60,000
(8) Whetstone dam with spillway		10,000
		225,000
Contingencies		50,000
Land damages		75,000
Total		350,000

Very respectfully, your obedient servant,

W. A. JONES,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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REPORT OF MR. C. W. WEEKS, ASSISTANT ENGINEER.

ST. PAUL, MINN., *May 10, 1897.*

COLONEL: The report of the survey of Big Stone and Traverse lakes is hereby respectfully submitted.

On Saturday a. m., December 26, 1896, accompanied by Recorder George E. Church, jr., I left Minneapolis, Minn., and arrived at Ortonville, Minn., at 4 p. m. the same day, and spent the time until the following night in making a general reconnaissance. On Monday, with the aid of a carpenter, we began the construction of three portable foundations for the tents to be used during the survey. These foundations or platforms were simply joists supported upon suitable stringers and floored over with shiplap; in the case of the two sleeping tents, low runners, shod with iron, were provided; but the cook tent, owing to its greater weight, was mounted upon a broad-gauge sled, with iron-shod runners 12 inches high. Frames were erected upon these platforms, over which the tents were stretched, the whole being thoroughly braced inside to withstand the fierce winds of that locality. When it was desired to move camp, a team was hitched to the runners of the platforms and the whole was drawn along in an undisturbed condition. Usually the two sleeping tents were drawn at once and the cook tent singly. But for this method of constructing and moving camp, the survey at this time of year would have been an impossibility.

Two days were spent preparing the camp, and on the 29th day of December the remainder of the party arrived, went at once to their quarters at the southern extremity of the lake, where the camp had been hauled, and the next day the survey began.

At this time the party consisted of W. C. Weeks, assistant engineer in charge; T. Milton Fowble, surveyor; E. Butterworth, transitman and leveler; two recorders, one cook and cook's helper, seven stadia men, and one teamster with team. During the survey additional teams were employed for short intervals.

One transit party under Mr. Fowble worked on the Minnesota side, the other under Mr. Butterworth worked on the Dakota side of the lakes, and this arrangement was preserved throughout the survey. Azimuth was obtained by observation on polaris, and carried forward by a triangulation system forming the skeleton or framework of the survey. The triangulation stations were given letters or numbers as they were observed upon and occupied or observed alone; those stations near the boundary line between Minnesota and Dakota were given a single letter, the others were given the successive letters of the alphabet with the prefix letter "M" or "D" as station was in Minnesota or Dakota. Distance between the various lettered stations were carefully measured by tape and the numbered stations located by computation. The lettered and numbered stations were so distributed as to form convenient checks upon the work of the transitman. From bulletin No. 72, U. S. Geological Survey, the elevation of the top of the rail at the depot at Ortonville was found to be 990 above the sea, and from this the elevation of Big Stone Lake was determined. Several permanent bench marks were established in the vicinity of Ortonville and Big Stone City, and at other important points on the survey, and particularly at the end of the work. Azimuth from permanent stations to surrounding objects was noted at the close of the survey and recorded for future use. All occupied stations were described, and referenced to trees or rocks when possible.

The survey was completed on the 12th day of February, 1897, including Big Stone and Traverse lakes and all marsh and low lands north of Lake Traverse as far as the north line of section 34, township 128, range 48, Minnesota. The weather during this time was on the whole very unfavorable to the prosecution of outdoor work. Up to the 1st of February nearly 40 per cent of the time had been lost. The party worked every day that it was possible for men to see, regardless of the intense cold, aggravated by the northwest gales.

From the results of this survey it appears that Big Stone and Traverse lakes offer very favorable opportunities for reservoir construction. The southern limit of this system would be determined by a dike and dam containing a navigable pass situated opposite the city of Ortonville, Minn. This dike would be about 4,200 feet long and have an average height of 14 feet above the present level of the ground. It would have to be thoroughly riprapped on the lake side to resist wave action, and lightly riprapped on the top and downstream face to resist erosion by the wind.

The waters of the Whetstone River should be diverted by means of an embankment situated at the point where the river enters the Minnesota Valley, just south of the site of Big Stone City, S. Dak., the diverted waters entering the lower end of Big Stone Lake by means of a canal to be constructed along the base of the bluffs, and running northward from the Whetstone River, through the dike previously referred to, into the lake. This canal would be about 3,400 feet long, and the conditions are particularly favorable for its economical construction. The embankment used for diverting the waters of the Whetstone River would be about 900 feet long

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and have an average height of 10 feet above the general level of the ground. A spillway of considerable capacity should be provided for in this embankment for protection against sudden rises of the river. The minimum elevation of the bottom of this pond above the embankment would be 2 feet above the flowage line of the proposed reservoir. Three bridges would be required across this canal; one railway bridge to carry the single track of the Chicago, Milwaukee and St. Paul Railway, and 2 highway bridges; also a suitable spillway to provide for the entrance of the waters into Big Stone Lake. The reason for this dike and canal, as outlined, is that otherwise several hundred acres of particularly fertile land would be ruined, and mill, railroad, and other valuable property destroyed; and even then it is doubtful if the dike absolutely necessary for the impounding of the reservoir waters could be materially shortened. The present Minnesota River would have to be widened and deepened for a distance of about 1½ miles below the dam. The amount of excavation necessary for this would not be excessive, because the present course of the river could be utilized for part of the distance.

The amount of land overflowed by raising the waters of Big Stone and Traverse lakes to elevation 975 would be inconsiderable, except in two places, where some damage would undoubtedly be done. At the upper end of Big Stone Lake nearly 7 quarter sections would be flooded, a large portion of which, however, is low lying and only accessible in a dry season. About 1¼ quarter sections of meadow land lying in sections 13 and 14, township 122, range 46, Minnesota, two islands containing about 1¼ quarter sections of stony ground and about one-eighth quarter section of desirable ground for the location of summer cottages and known as "The Peninsula" is approximately all the additional land that would be destroyed.

In order to make the waters of Lake Traverse tributary to Big Stone Lake a canal, controlled by suitable gates, would have to be constructed between the two lakes. This canal would be approximately 3½ miles long, have a maximum cutting of not to exceed 12 feet, and by utilizing the present course of the Minnesota River the quantity of excavation could be considerably reduced. Provision would have to be made for the entrance of the waters of the Minnesota River from the west. This entry would be at the point of maximum excavation of the canal. The winter level of Lake Traverse is about 8 feet above that of Big Stone Lake. Thus it is plain that any necessary slope could be given to the bottom of the canal. Provision should be made at the northern extremity against its obstruction by material thrown up by wave action. It would be advisable to make this canal navigable by small steamers and freight boats.

The outline and character of Lake Traverse suggest that the northern limit of the reservoir be made just north of the mouth of the Mustinka River. Big Stone Lake is generally deep throughout its length; Traverse up to the mouth of the Mustinka River broad, shallow, but open water, while beyond this point all open water disappears in a growth of rank aquatic vegetation, and the lake disappears in broad, shallow, rush-filled marshes and wet meadows. The incorporation of this part of the lake into the reservoir system would result in the flooding of considerable meadow and cultivated land reclaimed from the lake, while the evaporation from this broad, shallow area would prove to be a source of considerable loss. The northern limit of the reservoir would be determined by a dike running from the center of the northwest ¼ section 32, township 127, range 47, Minnesota, to the meander corner between sections 14 and 23, township 127, range 48, South Dakota. This dike would be 8,700 feet long, have a maximum height of about 10 feet, an average height of about 7, and should be riprapped on all sides. A spillway of large capacity, with a crest elevation of about 974, with provision for increasing this elevation by means of flushboards, should be constructed at a suitable place in this dike, and the dike should also be constructed capable of carrying a roadway.

The areas of Big Stone Lake and Lake Traverse at the time of the survey were 517,310,000 square feet and 386,330,000 square feet, respectively. Assuming a 12-foot range of gauge on Big Stone Lake and a 3-foot range of gauge on Lake Traverse, the capacity of the reservoir computed for the area at time of survey is 7,366,710,000 cubic feet. These ranges contemplate an equal rise and fall of the present (January, 1897) elevation of the surface of Lake Traverse, and 10-foot rise and 2-foot fall in Big Stone Lake. As the additional volume of Big Stone, due to the large excess of rise over fall, was not considered in the computation of the total cubic contents, this estimated contents is seen to be conservative.

The total area of land tributary to the reservoir system is about 2,215 square miles, of which 983 miles are tributary to Lake Traverse, and the remainder, 1,232 miles, drain into Big Stone. The lakes lie at elevations ranging from 20 feet at the northeast corner of Lake Traverse to 170 feet in the vicinity of Ortonville below the general elevation of the prairie country surrounding them. The edges of Big Stone Lake and the bottoms of the coulees are sparsely wooded. The uplands are, for the major portion, uncultivated.

The probable run off is assumed to be 0.1 of a cubic foot per second per square

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mile of area, which is a third of that observed in the case of the reservoirs on the Upper Mississippi. This assumption gives the amount of water available for Big Stone Lake direct to be 3,885,235,200 cubic feet and to Lake Traverse 3,099,988,800 cubic feet. The capacity of the Lake Traverse portion of the reservoir within the range suggested is only 1,158,990,000 cubic feet, but provision is made for the transfer of this excess to Big Stone Lake, and also temporary restraint of the water while such transfer is being made. The total cubic contents of the whole reservoir is about 380,000,000 cubic feet more than the available supply, based on the estimate of one-tenth cubic foot per second run off. If only this computed supply comes to the reservoir each year a volume equal to 900 cubic feet per second may be released for a period of three months. Some loss would undoubtedly be experienced in dry years from evaporation, particularly from Lake Traverse, which is broad and shallow; also the prevalence of winds would probably increase the rate of evaporation to a considerable extent.

The total cost of this reservoir system is estimated to be $745,965, divided as follows:

At mouth of Whetstone River.

An embankment 10 feet high, 30 feet wide on top, slopes 3 to 1, 900 feet long, containing about 20,000 cubic yards of earth, at 20 cents per yard	$4,000	
Cost of core for same	6,000	
Cost of spillway	10,000	
Land damages	10,000	
Total		$30,000
For a dam and dike opposite the city of Ortonville, Minn., an earthen embankment 4,200 feet long; height, 14 feet; width, 15 feet on top; side slopes 3 to 1, containing about 168,000 yards, at 12 cents per yard	$20,160	
Clay-core wall, 6-foot base, 3-foot top, 15 feet high, being 10,500 yards in the length of the dam, at $4 per yard	42,000	
Cost of dam, gates, etc	100,000	
Riprap, 28,000 yards at 50 cents and 35,000 at 30 cents	24,500	
Land damages	10,000	
Total		196,660
For the construction of a canal leading from the mouth of the Whetstone River to Big Stone Lake, having a width on the bottom of 100 feet, side slopes 3 to 1, a bottom elevation of about 974, and being 3,400 feet long, containing about 135,800 cubic yards, at 20 cents	$27,160	
Spillway at lake end	10,000	
Railway bridge and piers	10,000	
Two highway bridges and piers	10,000	
For additional grading for roads	5,000	
Land damages	15,000	
Total		77,160
For deepening and straightening the Minnesota River below the dam at Ortonville, being a ditch, the elevation of the bottom being 961, 100 feet wide on bottom, slopes 3 to 1, amounting to 150,000 yards, at 10 cents	$15,000	
Land damages	5,000	
Water-power damages	10,000	
One railroad and two highway bridges	20,000	
Total		50,000
Damages to lands bordering on Big Stone Lake, 3,000 acres, at $50 per acre		150,000
Canal between Big Stone Lake and Lake Traverse, containing, approximately, 340,000 yards, at 10 cents per yard	$34,000	
Gates, etc	20,000	
Two highway bridges	6,000	
End protection	8,000	
Land damages	15,000	
Total		83,000

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Dike at the north end of Lake Traverse, being 8,700 feet long, height 7 feet, 15 feet wide on top, slopes 3 to 1, being about 600 yards per station, or a total of 52,200 yards, at 15 cents	$7,830	
Core wall of clay, 1½ yards cross section for the length, being 4,350 yards, at $4	17,400	
Riprap, 52,200 square yards, at 50 cents	26,100	
Spillway and gates	20,000	
Land damages	20,000	
Total		$91,330
Total for reservoir complete, with 10 per cent added for contingencies.		745,965

W. C. WEEKS,
U. S. Assistant Engineer.

W. A. JONES,
Lieut. Col., Corps of Engineers.

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APPENDIX B B.

IMPROVEMENT OF MISSOURI RIVER AT AND ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPT. J. C. SANFORD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Missouri River between Stubbs Ferry, Montana, and lower limits of Sioux City, Iowa.
2. Removal of snags and other obstructions in Missouri River above Sioux City, Iowa.
3. Yellowstone River, Montana and North Dakota.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, July 16, 1898.

GENERAL: I have the honor to transmit herewith reports upon the works of this district for the year ending June 30, 1898.

Very respectfully, your obedient servant,

J. C. SANFORD,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF MISSOURI RIVER BETWEEN STUBBS FERRY, IN MONTANA, AND THE LOWER LIMITS OF SIOUX CITY, IOWA.

The physical characteristics of the Missouri River above Sioux City are described in Annual Report, Chief of Engineers for 1897, pages 333 and 334.

Between Greatfalls and Stubbs Ferry, in Montana.—Original conditions, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 334, 2178, and 2179.

In July, 1897, dike construction, which had been suspended on account of high water, was resumed under the project of November 30, 1894. At Griffin Bar, about 12 miles above Greatfalls, three dikes were built and the dike built in the previous year was repaired. Repairs

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were made to two of the dikes built in 1895 at Fox Island, about 55 miles above Greatfalls, and to the dam behind Wickners Island, about 45 miles above Greatfalls, also built in 1895. Three short dikes were built to improve a shoal below Wescott Island, about 9 miles above Greatfalls, which, by forcing the narrow channel close against a rocky point, had proved particularly dangerous to boats. By these and the earlier works it is thought that a 3-foot channel of sufficient width has been obtained between Greatfalls and Buckshot Island, about 16 miles; but the river has remained so high during the spring that a survey to show low-water conditions has not yet been practicable. In September an examination was made of the shoals on that part of the river between Griffin Bar and Cascade. It was found that at a number of places the improvement of which was not contemplated in the approved project there was an available depth of less than 3 feet, and at a number of others the depth reduced to low water was less than 3 feet. The season having been particularly favorable for the formation of shoals, as the river had fallen very rapidly after the June rise, it was thought that many of the latter class of shoals would cut out as the stage approached low water. On account of this uncertainty as to the permanency of many of the shoals, and as navigation would receive more immediate benefit by obtaining as soon as possible a 2½-foot channel to Cascade, it was decided to change the order of work by improving the worst shoals first, and at the same time carefully observing those whose permanency was uncertain. Accordingly, work was begun in October toward the improvement of Bird Creek Shoal, about 48 miles above Greatfalls, and one dike completed before the river closed by ice. This shoal forms at present the head of the 2½-foot low-water channel. Surveys were made during the fall to determine effect of works built in 1895 and 1896. At Fox Island, which had been the worst place in the lower part of the reach, an available depth of 5.8 feet at a stage of 0.9 foot was found, and at Wescott Island a depth of 4.6 feet at the same stage.

Following the above-mentioned examination between Griffin Bar and Cascade, surveys had been made of all the shoals then found and the survey maps compared with those of the survey of 1880, on which the original project (of 1892) had been based, to determine permanency of shoals. The comparison, in connection with more recent gauge data, showed that the stages of water stated on the 1880 maps were from 2 to 3 feet too low, varying in different portions of the pool (soundings were platted as taken), and that, correcting for this error, many of the present shoals not considered in the original project would appear on these maps, though the number of existing shoals largely exceeds that of the shoals existing in 1880. It also appears that many of the existing shoals did not exist at the time of submission of the project adopted November 30, 1894, or have since deteriorated. Owing to the above changed conditions between Greatfalls and Cascade, a revised project for improving the river between Greatfalls and the canyon next below Stubbs Ferry was submitted, and was approved January 4, 1898. No change is made in results contemplated nor in amount of work provided for above Cascade; but the estimate for the whole work is increased to $213,646.50, to cover the improvement of the increased number of shoals below Cascade. An estimate of $4,500 for annual maintenance is also included.

During the past spring four barges, necessitated by the increased towing distance on all work in the upper part of the Greatfalls-Cascade reach, have been built, a quarry has been opened and about 1,100 cubic

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yards of rock quarried, and brush cut and 1,200 fascines made for use in constructing proposed dikes at Bird Creek Shoal. Dike construction will be resumed as soon as the present flood subsides.

The total expenditures during the year have been $16,486.58.

The work, including the procuring of brush and rock, was done by hired labor.

Maps of the shoals improved during the year accompany this report.

The work has been in local charge of Asst. Engineer W. H. Wood, whose report is appended.

Greatfalls to Fort Benton.—No work done or projected.

Fort Benton to Carroll.—The project contemplates deepening and improving the channel by the removal of bowlders, by contraction works on the shoals, and by dredging. No work has been done since 1891, navigation having ceased, due to the construction of railroads paralleling the river. There was formerly an extensive commerce between lower river points and Fort Benton, nearly all the freight destined for Montana, Idaho, and the British Possessions north of these States having been brought by river.

Carroll to Sioux City.—In addition to removal of snags and other obstructions, work has been done at several localities, as described below.

At Bismarck Harbor.—Original condition, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 334, 335, 2179, and 2180.

In August, 1897, dike construction and repair, which had been suspended on account of high water, was resumed. During the remainder of the season the two short dikes for the protection of the left bank just below the bridge, which had been begun and nearly completed in the previous year, were completed, as was also the right bank above the bridge, in continuation downstream of the group of seven dikes constructed in 1895. Repair of the latter group was continued and completed so far as proposed under the present allotment. These repairs, begun in the spring, consisted in rebuilding the lowest dike of the group, No. 7, using the existing foot mattress, in restoring the destroyed portion of No. 5, in strengthening by strong T heads Nos. 1, 3, and 6 in order to prevent their further destruction, and in thoroughly repairing the bracing and screening of all old work. The construction of a second proposed right bank dike below this group was postponed on account of the cost of these repairs. Inclined and storage ways were constructed at the Rockhaven ice harbor for the use of the snag boat employed on this reach and of the fleet belonging to the Bismarck work. In November a channel was sluiced by the snag boat through the bar opposite Dike 7 to relieve the pressure on that dike, the growth of the bar having forced the channel strongly against it.

In March, 1898, channels were cut through the ice around the dikes, to lessen injury at the spring break-up.

When the ice broke up and went out, on April 7, it carried away the T head and about 90 feet of the stem on each of the following dikes, viz, Dikes 5 and 7 of the 1895 group and the right bank dike below them, built in 1897. All the other existing dikes received slight injuries. Preparations were made in May for strengthening by T heads the outer ends of the three dikes most injured and for making minor repairs to the others. Operations were suspended May 20 on account of the unusually early occurrence of the "June rise," but will be resumed when the river falls sufficiently.

The total expenditures during the year have been $10,526.25.

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The works are fulfilling their purpose in protecting the bank in their vicinity and in giving a more favorable direction to the channel above the bridge.

A map showing the location of Government and private improvement works on the reach accompanies this report.

The work, which has been done by hired labor and purchase of material, was in local charge of Asst. Engineer H. C. Gould in the fall of 1897 and the first half of May, 1898. Since May 16 it has been in charge of Asst. Engineer E. D. Vincent. Reports of these assistants are appended.

At Pierre and Fort Pierre.—Original condition, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 335, 2180, and 2181.

In July, 1897, construction work, which had been suspended on account of high water, was resumed. During the remainder of the season two pile dikes and a revetment 1,220 feet long below them were built for the protection of the lower part of Marion Island, leaving about 700 linear feet of bank below the revetment still unprotected. An incomplete crib-work dike below the Pierre steamboat landing, begun in 1895 and extended in 1896–97, was completed by adding a pile T head. Minor repairs were made to existing works. In February, 1898, a channel was cut in the ice around the Marion Island dikes, to lessen injury at the break-up. During the spring the ends of the dikes have been buoyed, the slight damage caused by ice and high water in the early spring repaired, and temporary protection work done where the present flood has threatened the upper bank at the Marion Island revetment.

The total expenditures during the year have been $13,551.95.

The works have nearly stopped the erosion below the Pierre steamboat landing, having formed a large accretion, and have protected that part of Marion Island covered by them. The Marion Island dikes extend to the proposed rectified shore line; and, when the revetment is extended to the foot of the island, the works designed to form and hold the proposed right-hand shore line for a distance of about 7,900 feet will have been completed. The dam behind the island has needed no repairs during the year and has caused the chute to fill with sand and drift to a height of 8 feet above low water. A marked improvement in depth and direction has occurred in the channel between Pierre and Fort Pierre.

A map showing the location of existing and proposed works opposite Pierre and Fort Pierre accompanies this report.

The work, which has been done by hired labor and purchase of material, has been in charge, while operations were in progress, of Asst. Engineer E. D. Vincent, whose report is appended.

At Yankton.—Original conditions, project, and operations to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 335 and 2181.

In July and August, 1897, the plant needed for beginning work was constructed or purchased. Two barges and four skiffs were built and two barges and a towboat purchased, part of the cost of the latter being paid from the South Sioux City allotment.

At the time of the submission of the project of March 23, 1897, and for some time thereafter, it was thought by the people of Yankton that the proposed bridge, about 3½ miles above Yankton, would be built during 1897; and for this reason the project had provided for expending the funds allotted from the appropriation of June 30, 1896, in protecting the left bank, just above the site of the bridge, the works

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forming part of those proposed in the general plan for the improvement of the reach. In the summer of 1897, work on the bridge not having begun, and an investigation of the situation having shown that the construction of the bridge in the near future had become very doubtful, it was thought best to expend the available funds in beginning the construction of a group of right-bank dikes above Yankton, forming part of the general plan, and designed to restore the Yankton steamboat landing. A revised project providing for this work was adopted September 3, 1897.

During the fall materials for the work were purchased, arrangements made for construction of a spur track and for use of land needed for a material yard, a temporary storehouse built, and the construction of five of the seven proposed right-bank dikes begun and continued until the work was stopped by ice. The plant used consisted of that belonging to this work, with some additional plant borrowed from the South Sioux City and Sioux City works.

In February a channel was cut in the ice around the dikes, to lessen injury at the break-up.

During the past spring the slight injuries caused by the ice have been repaired, repairs have been made to the towboat and two mattress punts built, and the construction of the sixth dike of the right-bank group begun. Dike work was suspended June 11 on account of high water. The present flood, which has been of unusual height and duration, has destroyed the piling in about 80 linear feet of one of the dikes, due to a heavy accumulation of drift against it, and has threatened serious erosion of the bank between and at the shore ends of some of the dikes. A small force has been constantly employed in temporarily protecting threatened portions of the bank at the site of the work and in moving property back from caving banks. The erosion at the dikes has thereby been minimized and all property has been saved.

The total expenditures during the year have been $26,555.74.

The dikes have checked the formerly rapid erosion in their vicinity, but are still too short to have decidedly altered the position of the channel.

Maps showing the location of work done and of proposed works accompany this report.

The work, which has been done by hired labor and purchase of material, was in local charge of Asst. Engineer A. H. Weber to June 14, 1898, and of Asst. Engineer Bathurst Smith since that date. Reports of these assistants are appended.

At Elkpoint.—Original condition, project submitted, and action taken thereon are described in the Annual Report of the Chief of Engineers for 1897, pages 335, 336, 2181, and 2182.

No work has been done during the fiscal year and no expenditure made.

At South Sioux City.—Original condition, project, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 336, 2182, and 2183.

The only work done during the year has consisted in the construction and purchase of plant needed for future work in this vicinity. A combined pile driver and grader has been constructed, except setting up the grading pump. Four skiffs have been constructed, and a towboat, part of the cost of which was paid from the allotment for work at Yankton, has been purchased. Construction of plant was done by hired labor and purchase of material.

The total expenditures during the year have been $4,080.48.

At Sioux City.—Projects and work done to June 30, 1897, are described

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in the Annual Report of the Chief of Engineers for 1897, pages 336, 2183, and 2184.

In August the work of protecting the left bank below the mouth of the Floyd River was begun. The work proposed for the protection of the bank consisted of revetment and short pile dikes. During the remainder of the season the revetment, consisting of a subaqueous mattress of woven willow brush, with upper bank sloped and paved, was completed except the upper part of the bank paving. This was completed during the past spring. It extends 824 feet from the Floyd River downstream. Twenty short dikes below the revetment were completed and shore protection and foot mattress for three others, the pile driver not being then available for completing them. The mattress for one of these is an extension of the revetment, and the locations of the other two are at points where the mattress laid may sufficiently protect the bank. The work has thus far protected the bank over the distance, about 7,400 feet, which had been threatened with erosion. Owing to the shortness of the dikes, however, which was necessitated by the excessive depths then existing close to the bank and to the unusually great distances between the dikes, due to the necessity of protecting a great extent of bank with limited funds, some of the dikes may in future have to be extended or intermediate dikes or revetments built.

Repairs were made in November and December, 1897, to eleven of the dikes constructed in 1895 near the upper limits of the city. In March, 1898, the outer ends of the lower four dikes of the system constructed in 1889 in front of Sioux City were repaired.

A storehouse for property belonging to this and other works was built in November and December, 1897, at the Sioux ice harbor.

The total expenditures during the year have been $18,698.97.

The work was in immediate charge of Asst. Engineer F. M. Towar to February 10, 1898, and of Asst. Engineer Bathurst Smith since that date. Full details are given in the appended report of the latter. The work has been done by hired labor and purchase of material.

Maps showing the existing works on the reach and work done during the year below the Floyd River accompany this report.

Ice harbors.—Original condition, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 337 and 2184.

The two ice harbors at Rockhaven, N. Dak., and on the Big Sioux River near Sioux City have been maintained in good condition, so far as the works on shore are concerned, by the watchmen employed in caring for Government property stored at these harbors. A well 92 feet deep has been driven at the latter harbor for the use of the watchmen and of the force frequently employed there on plant repairs. In the fall of 1897 these harbors were reached by steamboats only after considerable time and labor had been expended in sluicing channels through the bar which had formed in front of the Rockhaven ice harbor and the bar at the mouth of the Big Sioux River.

The total expenditures during the year have been $68.56.

River survey.—Project and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 337 and 2184.

During the year a few of the published maps have been distributed, in accordance with law. Examinations of the river have been made at Fort Benton, Mont., and Judith, Mont., where erosion had been complained of.

The water gauges at Wolfpoint, Mont., and Fort Buford, N. Dak., the readings of which had been discontinued, have been stored.

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The total expenditures during the year have been $108.20, mostly for freight liabilities of previous years.

WORK REQUIRED.

Stubbs Ferry to Greatfalls.—To complete the existing project for work between Greatfalls and the canyon next below Stubbs Ferry will require the expenditure of $162,646.50, of which $84,509 will be required to complete the work between Greatfalls and Cascade, 55 miles. One-half of the latter sum, say $42,000, can be profitably expended in the fiscal year ending June 30, 1900. Its expenditure will increase the depth that can be carried between Greatfalls and Cascade, and will, it is hoped, result in an increase of the commerce of the "Long Pool."

Carroll to Sioux City.—For remarks on the general improvement of this reach, 1,309 miles in length, and on improvement at isolated localities within the reach, see Annual Report of the Chief of Engineers for 1897, pages 2184 and 2185.

In the act of June 3, 1896, Congress provided for work at the following localities: Bismarck Harbor, Pierre and Fort Pierre, Yankton, Elkpoint, South Sioux City, and Sioux City. At Bismarck Harbor, Pierre and Fort Pierre, and Sioux City work had been done in 1895, based in each case on a general plan, not yet approved, for the improvement of a considerable reach of river in the vicinity, the work done forming a small fraction of the entire plan, and the work done under the above act has also been in conformity with these general plans. The same is true of the work done at South Sioux City in 1896–97, as it formed a part of the general plan for the Sioux City reach; of that done at Yankton during the past year, and of that proposed under present allotment for Elkpoint. To complete the work at all of these localities as provided for in the general plans would require the expenditure of $1,707,746.50 in addition to present funds and to the cost of improving 2¾ miles of river above the mouth of the Big Sioux River, for which no estimate was made on the general plan for the Sioux City reach. It is understood to be the intention of Congress to continue improvements at these localities, viz., Bismarck Harbor, Pierre and Fort Pierre, Yankton, Elkpoint, and Sioux City and South Sioux City; and for the purpose of economical work an estimate of $675,000 is submitted, with recommendation that the allotment of this amount be left to the discretion of the Secretary of War.

No estimate for maintenance of the two ice harbors in this district, at Rockhaven, N. Dak., and on the Big Sioux River, South Dakota, appears to have been approved, though an estimate of $5,000 annually for their maintenance is given in annual reports of my predecessors. I would respectfully repeat this estimate, as being urgently needed for properly maintaining the harbors.

Money statement.

July 1, 1897, balance unexpended	$140.908.73
June 30, 1898, amount expended during fiscal year	90,076.73
July 1, 1898, balance unexpended	50,832.00
July 1, 1898, outstanding liabilities	16,517.02
July 1, 1898, balance available	34,314.98

Amount (estimated) required for completion of existing project:	
Great Falls to Stubbs Ferry	162,646.50
Great Falls to Sioux City	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1900	717,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

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APPROPRIATIONS.

The appropriations and allotments, exclusive of those for snagging, for the Upper Missouri River have been as follows:

1876	$20,000	1888	$200,000
1878	42,500	1890	†300,000
1879	60,000	1892	‡150,000
1880	43,000	1894	110,000
1881	66,000	1895	40,000
1882	*115,000	1896	235,000
1884	140,000		
1886	60,000	Total	1,581,500

In addition to the above amounts about $60,000 from the appropriations for the survey of the river from Fort Benton to the mouth was spent on the part above Sioux City.

List of contracts in force during fiscal year ending June 30, 1898, improving Upper Missouri River, between Stubbs Ferry, Montana, and Sioux City, Iowa.

Name and residence.	Character and extent.	Price.	Date of approval.	Date of beginning.	Date of expiration.
		Per cord.	1897.	1897.	1897.
Patrick E. Byrne, Bismarck, N. Dak.	Furnishing about 900 cords of willow brush at Bismarck, N. Dak.	$1.99	Apr. 5	May 2	During working season.
		Per cu. yd.			
Northern Pacific Railway Co., St. Paul, Minn. *a*	Furnishing about 2,500 cubic yards of riprap stone at Bismarck, N. Dak.	1.25	June 8	June 8	Aug. 15.
John C. French, Sioux City, Iowa. *a*	Furnishing about 2,400 cubic yards of riprap stone at Sioux City, Iowa.	.35	May 12	Not fixed.	Sept. 1.
John C. Hayes, Pierre, S. Dak.	Furnishing about 5,000 cubic yards of riprap stone at Pierre, S. Dak.	.63	May 28	May 19	During working season.
		Per cord.			
Do	Furnishing about 2,000 cords willow brush at Pierre, S. Dak.	$1.27	....do	.....do	Do.
Moser & Ekroth, Mandan, N. Dak.	Furnishing about 300 cords willow brush near Mandan, N. Dak.	1.35	July 3	June 7	Do.
Mark Naughton, Sioux City, Iowa. *a*	Furnishing about 575 cords of willow brush at Sioux City, Iowa.	1.45	June 16	Not fixed.	Sept. 1.
Smith & Betz, Sioux City, Iowa. *a*	.....do.....	1.45	....do	.....do	Do.

a Extended.

COMMERCIAL STATISTICS.

During the calender year 1897, the number of boats engaged in carrying freight and passengers, exclusive of those which during the year did only a ferriage business is 11, with a total tonnage of 1,275 tons. The freight and passengers carried by them are as follows:

	Tons.
Coal and wood	4,045
Grain, hay and straw	4,728
Lumber	1,143
Sand, lime, and cement	1,953

*$2,832.42 of this transferred to work below Sioux City.
†$192,912 of this afterwards allotted to snagging.
‡$161.53 of this afterwards allotted to snagging.

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General merchandise and miscellaneous 4,901
Live stock 335
Passengers ..... number.. 3,950

The above figures show an increase of 6,737 tons of freight and 2,985 passengers over the amount carried in 1896.

Traffic by river reaches.

Year.	River reaches between—	Packages and bulk freight.	Passengers.	Live stock.
		Tons.		*Head.*
1890	Sioux City and Bismarck	9,735	4,322	2,974
	Bismarck and Fort Buford	2,467	184	43
	Fort Buford and Fort Benton	1,124	62	43
1891	Sioux City and Bismarck	10,410	1,749	4,683
	Bismarck and Fort Buford	2,645	130	59
1892	Sioux City and Pierre	2,614	32	6,043
	Pierre and Bismarck	7,247	177	2,315
	Bismarck and Fort Buford	5,301	278	300
1893	Sioux City and Pierre	5,456	12,513	23,137
	Pierre and Bismarck	6,256	137	20
	Bismarck and Fort Buford	2,125	12	2
1894	Sioux City and Pierre	1,491	3,095	9,258
	Pierre and Bismarck	19,171	16,362	41,356
	Bismarck and Fort Buford	4,461	102	1,849
	Greatfalls and Stubbs Ferry	28	903	.....
1895	Sioux City and Pierre	10,485	.....	.....
	Pierre and Bismarck	5,136	417	7
	Bismarck and Fort Buford	5,591	8	.....
	Greatfalls and Stubbs Ferry	50	2,204	.....
1896	Sioux City and Fort Yates	2,850	.....	670
	Fort Yates and Fort Berthold	7,106	283	364
	Greatfalls and Stubbs Ferry	500	692	.....
1897	Sioux City and Fort Yates	6,277	950	1,376
	Fort Yates and Fort Berthold	9,243	.....	.....
	Greatfalls and Stubbs Ferry	1,250	3,000	.....

List of steamers and gasoline boats plying on the Missouri River between Sioux City, Iowa, and Stubbs Ferry, Montana, during the year 1897.

Name.	When built.	Dimensions.			Tonnage.	Owner or manager.
		Length.	Breadth.	Depth.		
		Feet.	*Feet.*	*Feet.*		
Benton *a*	1875	197.0	33.0	5.0	394.08	James P. Boland, St. Louis, Mo.
Vint Stillings	1881	131.0	31.8	4.8	177.47	Selzer Bros., Sioux City, Iowa.
Mary E. Bennett	1888	65.0	14.0	2.0	21.71	R. A. Talbott, Sioux City, Iowa, sold W. F. Parker, Florence, Nebr.
Castalia	1892	110.0	24.0	3.6	75.00	B. S. Holmes, Sioux City, Iowa.
Iowa *b*	1897	91.0	18.0	2.7	48.03	B. H. Kingsbury, Sioux City, Iowa.
Ponca *b*	1894	50.0	11.0	3.0	17.50	John Austin & Son, Ponca, Nebr.
River Queen *b*	1896	48.0	14.0	2.3	15.95	Ed. Anderson, St. Helena, Nebr.
Josie K. L	1884	60.0	14.0	2.5	22.75	A. Larson, Yankton, S. Dak
Little Maud	1882	92.0	20.0	3.4	58.66	Joseph Leach, Running Water, S. Dak.
Myrtle *b*	1896	32.0	7.0	3.0	7.00	E. E. Lindsay, Wheeler, S. Dak.
Chamberlain *b*	1895	70.0	17.0	3.0	39.56	J. W. Sanford, Chamberlain, S. Dak.
Last Chance	1870	98.2	17.8	3.0	50.47	H. J. King, Chamberlain, S. Dak.
Capitola Butt	1885	83.7	23.3	3.3	57.31	Wm. Sims, Chamberlain, S. Dak.
Jim Leighton	1895	119.5	30.16	3.6	109.81	C. and N. W. R. R. Co., Pierre, S. Dak.
Peerless *b*	1897	83.0	21.0	3.5	*c* 50.00	E. Seneschal, Pierre, S. Dak.
Lizzie Reid	1896	66.0	16.9	3.2	*c* 28.00	Daniel C. Johns, Forest City, S. Dak.
Cannon Ball *b*	1895	.....	.....	.....	*c* 20.00	J. C. Leach and H. H. M. Smee, Cannon Ball, S. Dak.
F. Y. Batchelor	1878	178.6	31.0	4.0	313.00	I. P. Baker, Bismarck, N. Dak.
Imelda	1892	90.0	17.0	2.0	30.00	Do.
John H. Bloodgood *b*	1896	120.0	21.0	4.0	93.45	Do.
J. J. Hill	1892	50.0	10.0	4.5	*c* 10.00	J. D. Taylor, Greatfalls, Mont.
Minnie	1892	50.0	10.0	4.5	*c* 10.00	J. W. Cornelius, Greatfalls, Mont.
Boat without name	1896	80.0	16.0	3.5	*c* 27.00	Josephus Hamilton, Greatfalls, Mont.
Rose	1886	44.0	10.0	2.9	*c* 9.00	N. Hilger, Helena, Mont.

a Sunk and a total loss at Sioux City, Iowa, July 18, 1897.
b Gasoline boats.
c Estimated tonnage.

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Dates of ice closings and openings on the Missouri River above Sioux City, Iowa, and on the Yellowstone River at Glendive, Montana, 1897–98.

[Continued from page 2139, Annual Report, Chief of Engineers, for 1897.]

Locality.	Closing.	Opening.
Montana:		
Townsend	Dec. 1, 1897 Mar. 25, 1898	Feb. 26, 1898 Mar. 29, 1898
Greatfalls (gauge readings suspended)		
Fort Benton	Nov. 27, 1897	Feb. 6, 1898
Wolf Point (gauge readings suspended).		
Glendive	Nov. 27, 1897	Apr. 10, 1898
North Dakota:		
Fort Buford (gauge readings suspended).		
Bismarck	Nov. 21, 1897	Apr. 10, 1898
South Dakota:		
Pierre	Nov. 27, 1897	Mar. 7, 1898
Running Water (gauge readings suspended).		
Iowa:		
Sioux City	Nov. 27, 1897	Mar. 7, 1898

REPORT OF MR. W. H. WOOD, ASSISTANT ENGINEER.

CASCADE, MONT., *June 30, 1898.*

CAPTAIN: I have the honor to submit the following report of operations on the improvement of the Missouri River between Greatfalls and Cascade during the fiscal year of 1898.

On July 1 the steamer built during the spring was sufficiently completed to go to work, and on that day I took her from Greatfalls, where she had been receiving her machinery, to Goodrich ranch, where the outfit was stored, and then removed everything to Griffin Bar, where the first work was to be done. This was the long dike, 480 feet, on left bank at lower crossing, much the longest yet put in.

The steamer, since named the *Col. H. M. Robert*, fully came up to our expectations. Over a 7-mile course, upstream and down, she developed a speed of 7.86 miles per hour in still water, cutting off at half stroke, and with natural draft.

The long dike at Griffin was finished August 2 and work begun on the short one on right bank, upper crossing.

On August 13 you and Col. J. W. Barlow, Division Engineer, Northwest Division, arrived on the annual inspection tour. We took the steamer and went up the river as far as we could, being stopped at Cottonwood Ripple, 1 mile below Cascade, the steamer being unable to stem the current with only 3 feet of water on the ripple. On this trip we found half a dozen shoals with less than 3 feet at that time, the stage 0.9, and about as many more that would have less than 3 feet if reduced to low water.

Immediately after your visit I began surveys of Buckshot, Davis, and Wilson shoals and a project for expending the second appropriation of $16,000.

It was decided during your visit that several short dikes should be built just below Wescott Island, on right bank, which place was very bad this year.

These surveys, with maps and estimates, were finished and sent in on August 28.

On the 23d of August the upper right-hand dike at Griffin was finished and work begun on the short one directly opposite. This was finished on the 28th. A few repairs had also been made on the lower right-hand dike, built in 1896 and left somewhat incomplete.

On August 30 camp was moved to the foot of Wescott Island and work begun on the three dikes there.

On this day I received your order to make a rapid examination of all the shoals between Griffin and Cascade, with preliminary estimate for improvement, to be followed by a survey of each place, with detailed estimate.

On September 1 I took the steamer up river for this examination, returning on the 3d, and the preliminary report was sent in on that day.

While the steamer was away the repairs of the Fox Island dikes were made.

On the 8th I started with a party of six men to make the detail surveys, going by rail to Cascade, with two skiffs and camp outfit, and working downstream. This work was finished and camp at Wescott Island reached on September 16, surveys having been made at Cascade, Cottonwood Ripple, Island 134, Bird Creek, Travis Bar, Nelson, Thurman, Ulm, and Island 150.

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I found the lower dike at Wescott completed. On the 20th I received orders from you to close down the work, awaiting approval of project for the expenditure of the second appropriation.

On the 27th the last map and estimates for the above surveys were sent in, and on the same day a telegram was received from you to resume work.

On October 4 the second dike was finished. On the 5th I took the steamer to Great Falls and had the valves and eccentrics reset. This increased her speed from 7.86 to 8.50 miles per hour.

On the 7th and 8th I made surveys of Fox and White Bear Island shoals and of Wescott Island Shoal to find out the exact improvement made in the channel by the dikes built in 1895 and 1896. Tracings were sent in December 27, showing the improvement.

At Fox Island, the worst place on the lower part of the pool before improvement, there is now at the shoalest place, 5.8 at 0.9 stage. At Wescott Island, where the dikes were built only one year ago, there is 4.6 at 0.9 stage. This is very satisfactory.

On October 12 I received your letter directing me to go to one of the worst places at the upper end of the pool, instead of continuing in regular order up river, and I decided to go to Bird Creek Shoal as soon as Wescott was finished.

As I had already found out that the only rock available for work at Bird Creek Shoal was a small and unpromising outcrop just below Bird Creek, 1 mile below the work, and on the land of George Travis, I decided to see him before moving up; so I went by team to his place on the 14th. I could make no arrangement with him, though he said I might open up the quarry to see what it would amount to.

On the 16th and 17th the camp was moved up to Bird Creek, the steamer taking all five barges at once, more or less heavily loaded.

On the 18th, when I went to open the quarry, Travis refused to let me do anything. He said he leased the land from the State school board, and his lawyer advised him not to let the rock be touched. I started that night for Helena, the next morning saw the governor and other school land authorities, who called a meeting of the board and gave me written authority to quarry rock and cut brush on the school section. I returned to Cascade that night. As I heard from you that you would be out on the 22d, I did not start the quarry crew, as I could keep all hands busy making fascines. On the 22d you arrived and met Mr. Travis and told me to take out the rock in such a manner as to do the least damage possible to the property. We then went down river by steamer as far as the rocky bluff above Thurman. This is the only rock available for all the work between Ulm and Bird Creek. It is, fortunately, a very good quarry site, easily worked, the quantity unlimited. The Travis quarry furnished only enough rock for the one dike built this year at Bird Creek, the lower one, left bank. On October 28 the construction of this dike was begun and finished on the 13th of November.

On the 14th I discharged thirteen of the men and took them to Cascade, and on the 15th moved everything to Johnson's Ranch, opposite Nelson, and put up the storehouse for winter storage of the property.

Early in December I returned to Sioux City, and was engaged for three months in making maps and report and other necessary office work.

On December 22, in my report of work for the season, I submitted an estimate for four new barges, 12 by 50 feet, made necessary from the fact that in all the future work the rock haul was going to be a long one, instead of having the rock within 1 mile of the work, as has been the case heretofore. The lumber for these barges was ordered in February, and early in March I returned to the work, expecting to find the lumber delivered and to have the barges built by the time the river opened, so that dike building could be done before the rise of the river. I found the lumber had not come, and in spite of all that I could do it did not come until the 20th of April. In the meantime I had cut and bound all the fascines needed to complete the two upper dikes at Bird Creek, all that we could estimate on doing with the balance of appropriation, and had a quarry crew getting out the necessary rock at Thurman quarry.

This was finished by May 20, and the men discharged. By the end of May the barges were finished, except their decking, and launched. As the river was nearly bank full by this time the camp was moved to the high prairie bank just above the Bird Creek work, and the balance of the laborers discharged. Here the barges were decked and finished. The four barges have cost almost exactly $1,400, or $350 each.

Respectfully submitted.

W. H. WOOL,
Assistant Engineer.

Capt. J. C. SANFORD,
Corps of Engineers.

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Description of dikes built during fiscal year of 1898.

Dikes.	Length.	Crest above low water.	Length by tiers.				Number of fascines.	Cubic yards of rock.	Cost per foot of dike.	Total net cost.	Remarks.
			1 tier.	2 tiers.	3 tiers.	4 tiers.					
Griffin:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*					
Lower left	480	2	.....	370	70	40	1,426	1,968	$5.31	$2,547.50	
Upper left	125	2	.....	125	.....	.....	382	314	4.08	510.92	
Lower right	.....	.....	.....	.....	.....	.....	44	160	.....	176.49	Repairs of 1896 dike.
Upper right	160	2	.....	120	40	.....	680	740	6.31	1,009.66	
Westcott:											
Lower right	190	2	.....	170	20	.....	625	536	4.23	804.45	
Middle right	150	2	.....	150	.....	.....	527	523	4.53	679.27	
Upper right	120	2	.....	120	.....	.....	471	511	5.37	644.00	
Bird Creek, lower left.	385	2	200	185	.....	.....	812	627	3.96	1,525.77	
Repairs, Fox and Wickner.	.....	.....	.....	.....	.....	.....	.....	.....	.....	436.33	Repairs of 1895 dike.
Total, less repairs.	1,610	.....	200	1,240	130	40	4,967	5,379	4.80	7,721.57	

REPORT OF MR. H. C. GOULD, ASSISTANT ENGINEER.

MANDAN, N. DAK., *May 12, 1898.*

CAPTAIN: I have the honor to submit the following report of operations on the Missouri River in the vicinity of Bismarck, N. Dak., under my charge, between July 1, 1897, and December 17, 1897:

Construction, which had been in progress until June 30, 1897, under project adopted in 1896, was suspended during July, 1897, on account of high water. The only field work done during that month was the loading of the surplus piles, lumber, and other material at the dikes, Group D, on barges, which were towed to Rock Haven by the snag boat, where the material was unloaded and stored in the property yard. By August 5 the river had fallen enough to allow resumption of construction work.

DIKE CONSTRUCTION.

The driving of 26 piles, required to finish the outer 100 feet of Dike 1 E, was done from August 5 to 7. All the foot mattress and the first 80 feet of piling, bracing, and screening had been done in May and June.

The bracing and screening out to the head was done August 18 to 21. The head was partly filled with brush and rock and the screening in head was finished September 2 to 4.

The short dikes, 1 and 2 F, on east side just below the railroad bridge, of which the foot mattress and piling had been finished before the summer high water, were completed by putting on the braces and pole screen from August 11 to 14, and, on September 6, 85 yards more rock were placed in and about the heads. The screening was carried to the bank on short piles set deeply in the ground and well braced.

The total lengths and net cost (exclusive of superintendence, miscellaneous expenses, towing of plant, preliminary and subsequent handling and towing of materials, and with freight on materials estimated) of the new dikes built during the working season of 1897 are as follows: Dike 1 E, 230 feet, $2,320.36; Dike 1 F, 110 feet, $976.83; Dike 2 F, 120 feet, $887.70. The average total cost per foot of 2-row dike is $9.12.

In dike construction this year some improvements were made over previous methods. The longitudinal timbers, instead of being simply bolted to the side of the pile, were set on a shoulder about 2 inches deep, cut into side of the pile, and the cross braces were placed on top of the longitudinal timbers. This was for better resistance to downward pressure from weight of ice and drift. The tops of the piles were cut off even with the cross braces and diagonal braces were driftbolted on the piles. All projecting ends of timbers were sawed off. The T heads were partly filled with brush and rock.

This additional work, the short lengths of the dikes, and interruption from high water made the cost per linear foot of dike greater than in previous years.

DIKE REPAIRS.

On July 19, 9 piles were driven at Dike 1 D, to form a small head and connect with present end; near end of July, 22 braces and 80 linear feet of pole screen were put on this new part and a filling of brush and rock was placed in and about the head, using 11 cords brush and 8 yards rock.

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At Dike 2 D 6 braces were placed in the head July 28, and a filling of 5 cords brush and 7 yards rock was put in the head.

On July 19, 6 piles were driven at Dike 3 D for a small head. Late in July, 15 braces, 80 linear feet of pole screen, and a filling of 8 cords brush and 13 yards rock were put in.

At Dike 5 D, where an extension 290 feet long had been nearly completed before the summer rise, the temporary braces that had been placed on the outer 100 feet and T head were replaced by permanent timbers; 210 linear feet of pole screening were put on and a filling of 10 cords brush and 18 yards rock was placed in and about the head, all being finished by September 1.

At Dike 6 D the piles for a small head had been driven and temporarily braced in May. The temporary braces were removed, the permanent timbers and 110 linear feet of pole screen were put on.

Dike 7 D, 400 feet long, had been entirely rebuilt, except the pole screen on outer 110 feet. The stage of water had not permitted the timbers to be put on as low as desired, and, during August, the timbers on the outer 100 feet were removed, the piles cut off, and the timbers replaced at a lower elevation. Pole screening, amounting to 170 linear feet, was put on and a filling of 10 cords brush and 21 yards rock was placed in and about the head.

At about 90 feet from the outer end it was found that the bottom had been scoured to a depth of nearly 30 feet by the current passing under the large amount of drift lodged on upper side of the dike. This hole was partly filled by sinking three mattresses, each 60 feet by 22 feet and 1 foot thick, close to lower side of piling. This mattress was built in wooden frames left from the work of 1895, using 54 cords brush and 15 yards rock. At the shore end, where the piles are highest, a number of bents were braced by vertical diagonals made from old piles.

After the summer high water the main channel left the outer ends of the dikes and a wide bar was formed in front of them, extending from above Dike 2 to below Dike 6. This new channel crossed back to the west bank between Dikes 6 and 7, cutting away the bar there and making a very short turn around outer end of Dike 7. The bar opposite formed out toward the dike, narrowing up the passage and causing depths of from 30 to 35 feet near the dike. To better these conditions the snag boat sluiced an opening across the point of the bar opposite the dike late in October. When the ice started to run, November 15, the space all round Dike 7 was packed full of ice, the channel, past its end, closed up, and the running ice went through the opening started by the snag boat, across the point of the bar, thus greatly relieving the pressure on the dike.

PLANT.

Hauling out barges, etc.—The small pile driver that had been built to drive posts for the snag-boat ways, mentioned hereafter, was used in September to drive 72 posts on the level part of the yard, which were cut off about 2 feet above the ground, and 6-inch by 8-inch timbers were driftbolted on their tops, making eight lines of ways on which to move and store the barges. These ways were connected with the snag-boat ways on the incline by eight tilting timbers at the angle.

The barges were brought to Rock Haven September 9 by the snag boat, and the pile driver was taken up on the 10th by the *Imelda*. Barges Nos. 5, 6, 7, 8, 9, and 10 were hauled out by October 11, and the pile driver was up in place October 13. The hauling-out rigging was changed to the upper half of the yard, and the large barges, 1, 2, 3, and 4, were hauled out there by the 19th.

The decks and interior of all the hulls were well cleaned. The machinery on both pile drivers was disconnected, well oiled, and put in order for the winter.

Repair buildings, store property, etc.—All the tools, surplus material, etc., at the Dikes D were brought up to Rock Haven on the barges, sorted out, and placed in order in the warehouses.

The end doors in the store boat, being too small and inconvenient, were closed up and a wide, double door was made in middle of the side.

The old condemned barge on which the warehouse was built had become so unsound that it was in danger of falling over. The hoisting engines and other property in the house were removed, the house was blocked up, and the barge was taken to pieces. A good floor was made from the sides and some of the bottom planking, the house was lowered on it and well braced. A large shed was built against the side of the house, using old plank, etc., for housing the old engines, wheelbarrows, and other large pieces.

A complete inventory of all the property was taken October 29.

Hauling out snag boat.—In accordance with your verbal instructions, the building of permanent ways for hauling out the snag boat was started September 8. The way timbers, of Douglas fir, 10 inches by 12 inches, in 30 and 40 foot lengths, had been purchased last spring with lumber for the dikes and barges.

The incline required some additional grading, which was done from September 8 to 13, mostly with teams and drag scrapers, about 450 cubic yards being removed. Parts of the land pile driver built in 1895 were used to make a short driver, 21 feet

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high, with the old hoisting engine from barge No. 6. Posts were cut from the broken piles, from the Norway pine piles received from the East last fall, and from a few of the fir piles. The heads were trimmed and points were sharpened, and they were driven in twelve lines spaced 14 feet apart; 192 posts were put in from September 18 to 25, the average penetration being about 8 feet.

The tops of the posts were sawed off to a grade of 1 on 6¼, the 10-inch by 12-inch timbers were laid on and well driftbolted to the posts. Oak strips, 1¼ inches by 8 inches, were spiked on top of the timbers.

Four capstans were built similar to the two made last year. Six rollers were made, using the iron pipe and cast caps of surplus survey station marks. For straps to hold the upper tackle blocks, the old 1¼-inch chain (from burned dredge) was cut into six lengths of 45 feet, large links were made and welded in the ends and the ends in each strap were connected by strong shackles. To fasten the lower blocks to the boat six heavy shackles were purchased and six rope straps were made from new manila rope, 3 inches diameter. Six large "deadmen," cut from extra large fir piles, were set in holes 7 feet deep, the chain straps were passed around them and all were well covered with earth.

The snag boat *Josephine* came to Rock Haven November 3, and the crew, with a few extra hired men, commenced fitting up lines, blocks, and other rigging for hauling out. Another trip to Bismarck for material occupied parts of November 4 and 5. The placing of tackle, etc., was completed and the boat was hauled out to top of the incline on Saturday, November 6. On the 8th, 9th, and 10th she was raised by jack screws to nearly level position, the property was gathered up, stored, and turned over to the watchman, and the crew discharged.

SURVEYS AND MISCELLANEOUS.

In July a line of levels was run from the survey bench mark at Rock Haven to the Dike D, and closed on the bench mark in Mandan, to determine the elevation of high water during the spring breakup.

Measurements and soundings were taken at the intake of the Bismarck waterworks, a sketch made, and a report submitted on certain piling proposed by the water company.

Unserviceable property at Rock Haven was condemned by the inspecting officer on August 6, and destroyed or disposed of.

A shore-line survey, with soundings, was made October 16 to 20, extending from the lower end of the permanent rock and gravel bank below Rock Haven to opposite the old brewery buildings near the Bismarck Landing, the channel distance being 5 miles. A map of the survey has been made on a scale of 1 inch to 200 feet.

The office in Bismarck was closed on December 17, 1897. I returned here May 5, 1898, and started preparations to repair damages to the dikes caused by ice during the breakup, April 10 to 15, 1898, but as I have secured a more permanent position on Government work elsewhere, the repairs are to be completed by Asst. Engineer E. D. Vincent.

Very respectfully, your obedient servant,

H. C. GOULD, *Assistant Engineer.*

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. VINCENT, ASSISTANT ENGINEER.

BISMARCK, N. DAK., *June 30, 1898.*

CAPTAIN: I have the honor to submit herewith the following report concerning the Missouri River improvement work at Bismarck, N. Dak., under my charge during the latter part of the fiscal year ending June 30, 1898.

In March a channel had been cut through the ice around the dikes to lessen injury at the spring breakup. The ice, when it broke and went out of the river at this point, the 7th of April, carried with it the T-heads and 90 feet of each of the stems of Dikes 5 and 7, Group D, and the same amount from Dike No. 1, Group E, besides doing some minor damage to the other dikes in Groups D and F.

Work was commenced by Mr. H. C. Gould, my predecessor, the 4th of May, getting an outfit consisting of a steam pile driver on barge, and two lighters, ready and launched, in order to repair the damaged dikes and to protect them from further injury by the present June rise.

Mr. Gould having been called East, I was ordered to relieve him at this point, and did so May 16. At the time of my arrival the pile driver engines had been fitted up, the barge calked, and the ways ready to launch, and the calkers at work on the two lighters. The greater part of the material for repairs was in the water ready to be rafted down to the work. During the week ending May 22 the pile driver barge was launched and floated down to a position for driving at the broken end of Dike No. 5, Group D. Calking was finished on the two lighters, and they were also

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launched and partially loaded with fuel and material. One raft containing 30 piles was floated down to the repair work.

A rise in the river during the night of May 20 from 4 feet to 6.6 feet forced us by reason of the heavy drift running, to abandon the position taken with the driver at No. 5 and to haul it back under the dike for safety. The river continuing to rise and submerging the dikes, making conditions impossible for driving, the property afloat at Rock Haven and under the dikes of Group D was made as safe as possible, and on the 23d of May the force employed was discharged, with the exception of the regular watchman and one man employed occasionally when his services were needed to protect property. The river is still at the flood stage on this date.

The work of mapping this reach and of compiling the reports and statistics for the year just ended was taken up the early part of June, and has been carried forward through the month.

The present June rise has not to this date done further damage to the Government improvement work at this point. It is, however, cutting the unprotected banks immediately above the Group D system of dikes and has also attacked in places the old railroad revetment which protects the shore below Dike No. 7, Group D.

The rise is causing considerable filling in and about the Group D system of dikes, and when the flood shall have passed the bar growth there will be found more extensive than ever.

Very respectfully, your obedient servant,

EDWIN D. VINCENT, *Assistant Engineer.*

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. VINCENT, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *June 30, 1898.*

CAPTAIN: I have the honor to submit the following report of the operations under my charge on the Missouri River improvement work at Pierre and Fort Pierre for the fiscal year ending June 30, 1898.

At the close of the fiscal year of 1897 the work had been in progress under the present allotment since September, 1896. The project contemplated the repair of Marion Island dam; the protection of the river front by revetment from the mouth of Bad River downstream 2,800 to the bluff contact below; the completion of Dike No. 1, Group G, and the protection of as much of the lower shore of Marion Island by revetment and dikes as the funds available, after the other work was finished, would permit.

During last year Marion Island dam was repaired; the river's bank below Bad River protected; Dike No. 1, Group G, finished, with the exception of the T-head, and the root of Dike No. 2, Group E, constructed. This work was described and detailed in the report covering the operations during the fiscal year ending June 30, 1897. Since that date Dike No. 1, Group G, has been finished with a T-head; two dikes along Marion Island constructed, and 1,220 linear feet of shore line along the lower end of Marion Island protected by revetment. The improvement work, which had been suspended in June, 1897, by reason of the high water, was again taken up the latter part of July and carried forward continuously until the middle of November, when all field work was suspended and the fleet and plant were banked below the mouth of Bad River. The building material for construction purposes (brush and rock) was obtained along the river, and the conditions pertaining to its delivery at the work are fully described in last year's report.

The total amount of riprap stone used in construction under the present allotment was 6,982.8 cubic yards, costing, delivered at points of expenditure, $8,978.70, an average of $1.286 per cubic yard. The total amount of willow brush used was 2,542.8 cords, costing, delivered at the different works, $4,394.84, an average of $1.729 per cord.

MARION ISLAND DIKES (1 AND 3, GROUP F).

Dikes Nos. 1 and 3 of the four constituting Group F have been constructed since July. They are located about the center of the island and are respectively 150 and 410 feet in length. Leaving a 12-foot bank, they extend out with a continuous descent to the T-heads, which are 3½ feet above the low-water level of 1889. The dikes are of the two-row construction, and the piles are driven through a woven mattress, previously sunk to the bottom of the river. The average penetration of the piles in the lower and shorter dike is 23.1 feet and in the upper one 24 feet. The piles are of white oak, and were a lot left after the close of the season's work of 1895. The dikes were built into the main channel of the river and in water from 8 to 16 feet deep. Up to the close of the season last fall there has been but little deposit of sediment about these dikes, although after considerable shifting a well-defined channel had developed outside the T-heads.

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The net cost of Dike No. 1, 150 feet in length with T-head complete, as detailed in Appendix (Exhibit A), was $1,377.32, or at the rate of $9.18 per linear foot. The net cost of Dike No. 3, 410 feet in length including T-head, was $3,046.41, or at the rate of $7.43 per linear foot of dike constructed (Exhibit B).

MARION ISLAND REVETMENT.

The lower end of Marion Island had been protected by revetment from Dike No. 1, Group F, downstream 1,220 feet. The revetment consists of a woven mattress 60 feet in width, sunk alongshore and the bank above sloped to a grade of 3 to 1 and ballasted to the top with riprap stone. The mattress, in weaving, consumed 508.8 cords of willow brush, an average of 41.7 cords per 100 linear feet. The amount of riprap stone used in sinking mattress and ballasting bank was 1,539 cubic yards, an average of 126.1 cubic yards for every 100 linear feet of bank protected. The height of the bank, which is of sand, is from 8 to 12 feet, and it was graded to the slope with teams and scrapers at a cost of 8 cents per cubic yard. There was removed and washed back 4,374.4 cubic yards of earth. The total cost of revetment, complete as detailed in the appendix (Exhibit C), was $5,258.66, or at the rate of $4.31 per linear foot of bank protected.

DIKE NO. 1, GROUP G.

This dike, located 1,500 feet below the Pierre steamboat landing, had been left in an unfinished condition at the close of the season of 1895. There had been a foot mattress laid and ballasted the entire length of the proposed dike and a pole crib 8 feet wide and averaging 3 feet high, filled with rock, built out 345 feet. During the last fiscal year this crib was built and carried out 141 feet farther, a total distance of 486 feet, and sloping from the bank down to 4 feet 4 inches above the low-water level. Since then the dike has been finished with a pile T-head, making the construction, as completed, 507 feet in length, with the head 4.4 above the low-water mark of 1889.

The dike cost complete $3,265.08, an average of $6.44 per linear foot. The amount expended on its construction from the present allotment was $598.74. The pile T-head by itself cost $99.05, exclusive of the foot mattress.

DIKE REPAIRS.

There have been no repairs of consequence required on the dikes constructed. One pile was driven in the series in front of Fort Pierre and some walings and screenings replaced after the June rise. The crib dike in front of the waterworks at Pierre settled to some extent during the summer, but was repaired last fall. The ice break-up this spring tore off a few screening poles from Dike No. 1, Group F, but they have been replaced.

Field work was entirely suspended at Pierre and Fort Pierre the 18th of November, and the fleet, consisting of six 20 by 70 foot barges, four 8 by 24 foot punts, and a Vulcan steam pile driver on barge, were hauled out and stored on the bank below the mouth of Bad River. Tools, lumber, etc., were stored in a warehouse above Pierre and all property left in charge of a watchman. The river closed on November 27 at the 1.2 stage. As mentioned and detailed above, 1,220 linear feet of shore line along Marion Island has been protected by revetment. This protection was carried along as far as available funds would permit, leaving still unprotected about 700 linear feet of bank at the extreme lower end of the island. When this gap shall have been closed it will complete 7,800 linear feet of continuous shore protection on the left bank of the river, extending from the bluffs below Bad River to about the center of Marion Island.

At the close of the working season last fall and the storing of the plant for the winter, the office work was taken up at Sioux City the 1st of December. Maps were made, covering the reach proposed to be improved, showing works constructed to date. Reports were made and statements compiled relative to the season's work and estimates made covering future expenditures. The office work was completed the last of February and the Pierre force reduced to the watchman with the property at the work.

During February, in order to protect the improvements along Marion Island, a channel was cut through the ice 8 feet in width and 2,490 feet in length, entirely around Dikes 1 and 3, Group F, and carried at an angle to the adjoining shore above. The ice cut averaged 9½ inches in thickness. The total cost of cutting channel, at $1.23 per 100 linear feet, amounted to $30.56.

The break-up of the ice in the river at Pierre this spring was very moderate. The ice began to move out the 1st of March, and by the 7th the river was entirely clear. It did no damage to existing works, except tearing out a few screening poles from Dike No. 1, Group F. Later, however, when the river began to rise, it began to

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wash and cut the sand bank above the mattress on the revetted shore of Marion Island, and the washing has continued to some extent through the present June rise. To the 10th of May it had made a perpendicular cut from 1 to 2 feet deep, about 2 feet above the mattresses and 6 feet under the top of the bank, for a distance of 900 feet. At present the bank is covered by the high water, and very little damage is being done. Further cutting may be apprehended when the river begins to fall, especially if the customary high winds prevail, as the latter are quite an element in the cutting of the banks along the Missouri River. The unprotected 700 feet of bank at the extreme lower end of the island is also cutting to some extent. The watchman at Pierre has been working to prevent the cutting above the revetment as much as possible.

The river at present is holding a good channel across the bar from the steamboat landing at Pierre to Marion Island and along down the Fort Pierre side, although quite a volume of water is at present running down the right bank behind La Fromboise Island.

The Marion Island dikes are doing good work in causing a deposit to form along that shore, one small bar at the root of Dike No. 3, Group F, having already appeared at the 8.0 stage of the river.

Marion Island dam has stood the spring break-up and the present June rise perfectly, and has caused the chute it closes to fill with sand and drift to the 8.0 stage of the river, which, it would seem, effectually closes that which, before the dam was constructed, was a lateral channel of the river 900 feet in width.

Very respectfully, your obedient servant,

EDWIN D. VINCENT, *Assistant Engineer.*

CAPT. J. C. SANFORD,
Corps of Engineers, U. S. A.

Net cost of construction of Dike No. 1, Group F, along Marion Island.

[Length 150 feet.]

	Percentage.	Cost.	Total.
Grading: 99.3 cubic yards bank, at $0.1096 per cubic yard	0.8		$10.88
Weaving mattress: 80 cords willow brush delivered on barge, at $1.27 per cord		$101.60	
Towing same to works, at 25 cents per cord		20.00	
Total cost 80 cords willow brush delivered at work, at $1.52		$121.60	
Weaving 6,800 square feet of mattress at $0.0241 per square foot		163.88	
1,640 pounds ⅝ inch wire strand at $2.557 per 100 pounds		41.94	
Estimated charges on wire		13.00	
Towboat services while supporting mattress, 1½ days at $20		30.00	
Total cost of weaving 6,800 square feet of mattress, at $0.0545 per foot	26.9		370.42
Ballasting mattress:			
107.2 cubic yards riprap stone delivered on barge, at 63 cents		$67.54	
Towing same to work, at $0.3731		40.00	
Total cost 107.2 cubic yards stone delivered at work, at $1.0032		107.54	
Labor, sinking 6,800 square feet mattress, at $0.003		20.41	
Total cost ballasting and sinking 6,800 square feet mattress, at $0.187 per foot	9.3		127.95
Driving piles:			
33 oak piles 1207.8 linear feet, at 27 cents per foot [a]		326.10	
Driving 33 piles, at $5.46		180.70	
Total cost 33 piles in place, at $15.34	36.7		506.27
Bracing and screening:			
10 cords screening poles, at $2.25 per cord		$22.50	
3,035 feet B. M. bracing material, at $4.90		14.87	
Hardware (bolts and spikes)		9.58	
		46.95	
Towing material to work		37.00	
Labor		71.30	
Estimated freight charges		57.00	
Cost of screening and bracing 150 linear feet of dike, with T-head, at $1.412	15.4		212.25
Administration and office expense	10.9		150.00
Total net cost of 150 linear feet of 2-row dike, including T-head, at $9.182 per foot	100		1,377.77

[a] 33 piles, amounting to $326.10, were on hand from former appropriation.

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Net cost of constructing Dike No. 8, Group F, along Marion Island.

[Length 410 feet.]

	Percentage.	Cost.	Total.
Grading 99 cubic yards bank, at $0.131 per cubic yard	0.5		$13.88
Weaving mattress:			
158.1 cords willow brush, delivered on barge, at $1.27 per cord	$200.79		
Towing same to works, at 34 cents per cord	53.63		
Total cost of 158.1 cords willow brush, delivered at works, at $1.609		$254.42	
Weaving 18,800 square feet of mattress, at $0.0171 per square foot		321.31	
2,932 pounds ⅝-inch wire strand, at $2.557 per 100 pounds	$76.25		
Estimated freight charges on wire	23.40		
		99.65	
Towboat services, assisting construction		20.00	
Total cost of weaving 18,800 square feet of mattress, at $0.037 per square foot	22.8		695.88
Ballasting mattress:			
195.8 cubic yards riprap stone on barge, at 63 cents per cubic yard	$123.35		
Towing same to works, at $0.383 per cubic yard	75.00		
Total cost of 195.8 cubic yards stone delivered at works, at $1.012 per yard		198.35	
Labor, sinking 18,800 square feet of mattress, at $0.0022 per square foot		40.94	
Total cost of ballasting and sinking 18,800 square feet of mattress at $0.0127	7.9		239.29
Driving piles:			
90 oak piles, 3,294 linear feet at 27 cents per foot *a*		889.38	
Driving 90 piles, at $3.475 each		312.22	
Total cost of 90 piles in place in dike, at $13.35 each	39.4		1,201.60
Bracing and screening:			
20.6 cords screening poles, at $2.25 per cord	$46.35		
8,673 feet B. M. bracing material, at $4.75 per M	42.50		
Estimated freight charges on lumber and hardware	154.75		
Hardware (bolts and spikes)	25.57		
		269.17	
Labor		318.40	
Towboat services		10.00	
Total cost bracing and screening 410 linear feet of dike, at $1.454	19.6		597.57
Administration and office expense	9.8		300.00
Total net cost of 410 linear feet of 2-row dike, including T-head, at $7.43 per foot	100		3,047.72

a 90 piles, amounting to $889.38, were on hand from former appropriation.

Net cost of 1,220 linear feet, Marion Island revetment.

	Percentage.	Cost.	Total.
Clearing and grubbing 1.7 acres of ground along shore, at $24.82 per acre		$42.19	
Grading shore, 4,374.4 cubic yards excavation, at $0.0784 per cubic yard		342.87	
Total cost of grubbing and grading 1,250 linear feet of bank, at 38 cents per foot	7.3		$385.06
Weaving mattress:			
508.8 cords willow brush, delivered on barge, at $1.27 per cord	$646.17		
Towing same to works, at $0.9575 per cord	487.19		
Total cost of 508.8 cords willow brush, delivered, at $2.272 per cord		1,133.36	
Weaving and anchoring to bank 75,000 square feet of mattress, at $0.0125, or 1,220 linear feet of 60-foot mattress, at $0.773 per foot		942.99	
4,794 pounds ⅝-inch wire strand, at $2.49 per 100 pounds		119.37	
Estimated freight charges		60.00	
Total cost, 75,000 square feet of mattress, at 3 cents per square foot, or 1,220 linear feet, at $1.848	42.9		2,255.72

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Net cost of 1,220 linear feet, Marion Island revetment—Continued.

		Percentage.	Cost.	Total.
Ballasting:				
1,538.9 cubic yards riprap stone, delivered on barge, at 63 cents	$969.49			
Towing same to works, at $0.4795 per cubic yard	737.91			
Total cost of 1,538.9 cubic yards riprap stone, delivered at works, at $1.109 per yard			$1,707.40	
Labor, ballasting 106,250 square feet of mattress and bank, at $0.0021 per foot			223.91	
Total cost, ballasting 1,250 linear feet of revetment, at $1.545 per foot		86.7		$1,931.31
Administration and office expense		13.1		686.57
Total net cost, 1,220 linear feet of revetment, at $4.31 per foot		100		5,258.66

REPORT OF MR. A. H. WEBER, ASSISTANT ENGINEER.

YANKTON, S. DAK., *January 1, 1898.*

CAPTAIN: I have the honor to submit the following report of operations under my charge on the improvement of the Upper Missouri River at Yankton, S. Dak., from July 1, 1897, to January 1, 1898:

No field work was done during the previous fiscal year, excepting to make a survey of the reach, upon which to base a project of improvement.

From July 1 to September 11, I was engaged in your office upon the preliminaries incident to inaugurating the proposed construction work. Several trips were made between Sioux City and Yankton for the purpose of inspecting the river, investigating the supply of available brush and stone, and obtaining such information as could be had regarding the status of the proposed bridge. A distance of 30 miles was covered, partly by skiff and partly by team, on an inspection trip. Several patches of brush were located, but no stone suitable for the work could be found. There is an abundance of soft, chalky stone, locally known as "chalk rock," which disintegrates very rapidly when taken from its native bed and exposed to either air or water, and therefore is unsuited for this work. It is used in connection with other materials in the manufacture of cement.

On the 27th of August you submitted a revised project to the Chief of Engineers, which contemplated a change in the location of the work to be done under the present appropriation, from the stretch of river above the site of the proposed bridge to the reach between it and the city of Yankton. This project was approved September 2, and I made preparations to start the work at once. I went to Yankton September 11, and on the 13th established an office. Active operations were carried on from this time until December 8, when the office was closed for the winter.

SURVEYS.

A small party was started September 15 to make a resurvey of the river in the vicinity of the proposed work, and to locate the positions of the several dikes to be started. This survey was platted at once, and it showed that Dike No. 1 of the proposed system fell on a shore bar that had made out and downstream from Ambrose Island since the survey of September, 1896, and that extensive erosion had taken place along the Nebraska shore, which will necessitate an additional length of dike work over the project as laid down last year, aggregating about 1,200 linear feet. At spare times, during the month of October, a system of permanent △ stations were established, extending from the bridge site down to the lower city limits. A low-water survey of the reach was started on the 12th of November and completed on the 18th, consisting of the location of all bank and bar lines and the sounding of 79 cross sections.

A complete map, on a scale of 1 inch equals 1,000 feet, was platted and inked, and a detail map, on a scale of 1 inch equals 400 feet, was platted in pencil.

DIKE CONSTRUCTION.

It was decided to start five of the proposed dikes this season and extend each one as far as the existing conditions and the limited time would permit, with a view of protecting as great a length of exposed bank as possible from further erosion.

The pile driver being owned in common by the Sioux City and Yankton divisions, and being required at the former place most of the season, the number of piles to be

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driven had to be reduced to the minimum that would carry the dikes out sufficiently to protect the bank between them. Not being so restricted in time in the construction of the foot mat, it was carried some distance farther (excepting on Dike No. 4) than the piles were driven. The driving of mooring piles began September 25, on Dike No. 2, and was completed on Dike No. 6 on October 2. The piles were driven about 20 feet apart, one row for each dike, excepting on No. 4, where two rows were driven on account of swift and deep water. The grading of the shore ends of the dikes began September 27, on Dike No. 2, and the foot mat was started on the 28th. This work was carried from dike to dike consecutively downstream, and was finished November 3. The mattress was made 50 feet wide and was woven in the usual manner and strengthened with a system of ½-inch wire strand. Driving dike piles began September 29, on Dike No. 2, and continued steadily until completion on October 11. Two rows of piles were driven (10-foot centers), and at the stream end an ice break consisting of six additional piles in the form of an inverted V was driven. The piles were braced with sawed pine timbers, longitudinally and transversely, ½-inch screw bolts being used to attach them to the piles. An extra bracing of pieces of oak piles was used in the ice break to give it sufficient strength to withstand the break up in the spring. The bracing began October 5 and was completed October 22.

The screening or curtaining was done as follows: A longitudinal waling piece 4 by 6 inches by 22 feet was spiked to the lower row of piles with 8-inch boat spikes just above the water line. Screening poles of cottonwood or willow were attached to the wale and to the top longitudinal brace with 20-penny and 30-penny nails. An average of 15 poles was used for each bent. The mattress was woven and sunk before the dike piles were driven. An average thickness of 3 inches of stone was placed on the mattress.

PLANT.

As there was no plant belonging to the work, it had to be built or purchased. The following pieces were thought necessary: 1 steamboat, 1 pile driver, 1 mattress barge, 4 material barges, and 4 skiffs.

The steamer *Pauline*, a stern-wheel boat 95 by 23½ by 3.3 feet, with 10½-inch by 3-foot engines, was purchased for $3,000 and paid for partly from the Yankton and partly from the South Sioux City allotments. Two barges, 20 by 70 by 5 feet, were built at Sioux ice harbor. They are made of pine lumber from Minnesota. The sides are of 4-inch, the bottom of 3-inch, and the deck of 2-inch plank. There are three longitudinal bulkheads running from stem to stern, the center one of 4-inch and the sides of 3-inch stuff. Two barges were purchased for $650 at South Sioux City. One barge 16 by 60 by 3 feet was borrowed from Sioux City for a mattress barge. A new barge built at Sioux City, 18 by 70 by 5 feet, was used to put a pile-driver outfit on. Leads were built at Sioux ice harbor. A Vulcan-Nasmyth steam hammer and an American hoisting engine were purchased. Two small boilers were hired temporarily and used during the fall. Four skiffs, 21 to 22 feet long, were built.

CARE AND REPAIR OF PLANT.

The boiler of the *Pauline* was found to be leaky and in need of repairs shortly after her purchase. Two new sheets were put in, and a patch put on a leaky flue. Slight repairs were made to her deck, and a new splash bulkhead was put in. The *Pauline* took one tow to Sioux City to winter, consisting of the pile driver and two barges, and it was the intention to have her return for the other three barges, but the season was so far advanced and navigation so difficult, on account of extreme low water, that she was ordered into winter quarters at Sioux ice harbor, and I was instructed to pull the barges out on the bank. A point was selected just under Dike No. 4, where the bank was graded to a slope of about 1 on 2½. A temporary and inexpensive set of ways, consisting of a few piles, bracing timbers, and old railroad ties, was constructed. A simple arrangement for tilting at the top of the slope was made with bracing timbers hinged in the center to pieces of piles planted in the ground. The work of grading began on November 17, and on the 22d the ways were completed. On the 23d and 24th the three barges were pulled out. A watchman has been left in charge of the storehouse and yard.

MISCELLANEOUS.

A storehouse, 14 by 24 by 8 feet sides, with a gable-shingled roof, was built near the site of the work. The sills are so framed that when desired it can be moved on to a barge for transportation. The construction of this house began September 17, and was finished on the 24th.

To facilitate the handling of materials brought by rail a side track was laid on the cement works railroad track about 3 miles above Yankton. A tract of ground for

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storage purposes at the side track and another at the river bank, with a right of way between them, were rented for a period of one year.

MATERIALS.

Two hundred and forty-eight oak piles were received during the season. One hundred and twenty-six were borrowed from Sioux City before those ordered for Yankton had arrived. These were taken to Yankton on barges. One hundred and twenty-two were received by rail at Yankton and hauled by team to the river bank, a distance of about three-fourths of a mile. Five hundred and forty-two and fifty-five hundredths cords of brush were received on barges under written agreement. One thousand five hundred and fifty and six-tenths cubic yards riprap stone was received on our side track from Dell Rapids, S. Dak., and hauled to the storage ground on the river bank by teams. Sixteen thousand three hundred and thirty-one feet B. M. pine bracing timbers were received at Sioux City and transported to Yankton by barges.

STEAMBOAT SERVICE.

The *Pauline* was put in commission September 8, at Sioux City, and continued in service until November 24, when she went into winter quarters at Sioux ice harbor. During this time she was employed at Sioux City twelve days, in towing between Sioux City and Yankton thirty-two days, and on the work at Yankton thirty-four days. Her crew consisted of master and pilot, 1 motorman, 1 stoker, 1 watchman, 2 deck hands, and a cook.

Very respectfully, your obedient servant,

A. H. WEBER,
Assistant Engineer.

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

REPORT OF MR. BATHURST SMITH, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *July 9, 1898.*

CAPTAIN: I have the honor to submit the following report on the work done on the improvement of the Upper Missouri River at Yankton, S. Dak., during the latter half of the current fiscal year.

During the month of February an ice channel, 8 feet wide and 3,735 feet long, was cut from the shore below Dike 5 around the outer ends of the dikes to the shore above Dike 3. The ice broke up March 7 and went out quietly, doing no damage, except to take out some of the screening on the dikes. This damage was repaired in April.

In March a camp was established and a small force of men employed to cut brush about 12 miles above Yankton. Two hundred and eight cords were cut and hauled to the river bank. This brush was loaded on barges and brought down to the works in May. The three barges on the bank at Yankton were calked and launched in the latter part of March.

Repairs were made on the steamer *Pauline* at the Sioux ice harbor at Sioux City. These repairs were finished May 7, and she started from Sioux City for Yankton with her first tow May 9. She made four trips from Sioux City to Yankton, towing plant and material for the work, and also towed barges and material at Yankton.

A large horizontal boiler was placed on the pile driver and a house was built over the machinery. There was some delay in getting the material to repair the boiler and the driver was not ready for service until May 21. The *Pauline* started from Sioux City with the driver May 23, reaching Yankton May 25. Pile driving was begun May 26 at noon, and continued, with several interruptions, until June 10 when work was suspended on account of high water. Four mooring piles were driven to an average penetration of 18.5 feet. Eight bents were driven in Dike 6 and 14 bents in Dike 7. Forty-four dike piles were driven to an average penetration of 24.8 feet.

A foot mattress, 50 by 145 feet, was woven and sunk at Dike 7, as far out as the piles were driven.

Bracing followed closely the driving and weaving, and was completed June 11.

All work of construction was suspended June 11 on account of the high stage of the river.

Since June 11 no work has been done, except what was necessary for protection of the work and preservation of property and material. On June 9 a breach occurred in Dike 5, just inside of the head, caused by a pile of drift, which had accumulated against the dike. Three bents went out at first; 5 more bents have since gone out.

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Some work has been done to prevent the cutting away of the bank just above Dike 4, which was caving and threatened to cut behind the dike. The cutting at this point rendered it necessary to move the storehouse back 35 feet.

The river has been cutting considerably at the rock pile on the left bank just above the site of the bridge. Six barges of rock were loaded and transferred across the river and the remainder was moved back about 45 feet.

Two small punts, for use in weaving mattress at the dikes, were built in the latter part of April.

The white-oak piles used on the work were unloaded from the cars at Sioux City and loaded on barges and towed to Yankton.

Assist. Engineer A. H. Weber was in charge of the work at Yankton until June 14, when he resigned to accept a commission in the brigade of volunteer engineers.

Maps of the locality, showing the work accomplished during the fiscal year, accompany Mr. Weber's report.

Very respectfully, your obedient servant,

BATHURST SMITH,
Assistant Engineer.

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

REPORT OF MR. BATHURST SMITH, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *June 30, 1898.*

CAPTAIN: I have the honor to submit the following report on the work done on the improvement of the upper Missouri River at Sioux City, Iowa, during the fiscal year ending June 30, 1898:

The operations for the year comprise the repair of old plant, the construction of new plant, the repair of old dikes, the protection of about 7,394 feet of the left bank below the Floyd River by the construction of a revetment and a group of short dikes below it, and the construction of a warehouse at the Sioux ice harbor.

REPAIR OF OLD PLANT.

Four of the old barges were hauled out on the bank, recalked, and repaired during July and August. A few minor repairs were also made on the small steamer *Josie*, which did nearly all the towing for the work at Sioux City.

CONSTRUCTION OF NEW PLANT.

Four skiffs, 20 feet long, were built, and four bilge pumps were made for use on the work at Sioux City. On the pile driver the following work was done: A deck was put on the barge and was calked; the leads were built; the machinery was put on and a house was built over the machinery.

REPAIR OF DIKES.

Twelve dikes, of the upper system of dikes constructed in 1895, were damaged by the breaking up of the ice in the spring of 1897, and they were repaired in November and December. Fifty-six piles were driven in Dikes 10 to 16, inclusive, to an average penetration of 25.3 feet, and the outer ends were rebraced.

The outer ends of Dikes 5, 6, 8, and 9 were also rebraced; 10,700 feet B. M. of lumber were used in bracing these dikes. The outer ends of the lower four dikes of the system constructed on the city front in 1889 were rebraced in March, 1898.

PROTECTION OF THE LEFT BANK BELOW FLOYD RIVER.

The project for the expenditure of the amount allotted for this work, approved June 10, 1897, provided for the protection of the left bank from further erosion, from the mouth of the Floyd River to the bluff point about 4,500 feet below the Chicago, St. Paul, Minneapolis, and Omaha Railway Bridge, by the construction of revetment and a system of short dikes. This portion of the city front was threatened by changes in the position of the channel, and at several points dangerous encroachments on valuable property had been made.

REVETMENT.

The revetment constructed extends from the mouth of the Floyd River to the upper dike of the system, a distance of 824 feet, and is designed to protect the upper

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end of the system of dikes. Grading for the revetment was begun October 13 and finished November 6. The bank, 18.5 feet high, was graded to a slope of 1 on 3 by teams with plows and scrapers. Six thousand four hundred cubic yards of earth were removed.

Mattress weaving was begun October 20 and finished November 12. The brush for the revetment and dikes was furnished by contractors at $1.15 per cord, loaded on barges. The work was delayed by the slow delivery of brush. The mattress was woven 78.5 feet wide and 12 inches thick, and was strengthened by three-eighths-inch wire strand, woven through it in parallel rows, 10 feet apart, both longitudinally and transversely. The longitudinal rows of strand were placed on the under side of the mattress, the transverse on the upper side, the lower strand being drawn up through the mattress at their intersection and looped over the upper strand. The transverse cables were fastened to the outer and inner selvages of the matress and carried up the slope and fastened to "deadmen" buried above the high-water line. The mattress extended about 9 feet from the water edge up the slope of the graded bank; 341.13 cords of brush were used and 64,630 square feet of mattress were woven.

The work of ballasting the mattress and paving the bank was begun November 1 and finished November 17, to an elevation of 6.3 feet above low water, all the rock on hand being expended. A further supply of rock was obtained in February, 1898, and the revetment completed to an elevation of 13 feet above low water. The rock was placed 3 inches thick on the mattress, 10 inches on the lower half of the bank, and 8 inches on the upper half. Most of the rock for the revetment was unloaded from cars on a switch, parallel with and about 25 feet back from the top of the graded bank; 1,524.33 cubic yards of rock were used on the revetment.

The cost of the revetment is shown in detail in Exhibit A, attached to this report.

DIKES.

The dikes, as projected, consisted of a system of 23 short two-row dikes, extending from a point 2,070 feet above to a point 3,860 feet below the Chicago, St. Paul, Minneapolis and Omaha Railway Bridge. Of these, 20 dikes, with a total length of 2,046 feet, were completed, and the mattresses were woven and ballasted and the bank paved for the remaining three. The river bank, for a considerable portion of the distance below the bridge, had been protected by the Sioux City and Pacific Railroad Company, whose tracks are close to the bank, but this work had deteriorated and had failed in a good many places.

The dikes are similar in general features to those previously constructed on the Upper Missouri River, with the exception that the T-heads are more strongly braced and are built at a lower elevation. The stems of the dikes consist of two rows of piles 10 feet apart, the piles in the rows also being 10 feet between centers. The T-heads, 35 feet in length, contain three rows, 5 feet apart, the piles in the rows being 10 feet between centers. In some of the dikes the lower two piles of the middle row of the T-heads are omitted. The upper ends of the T-heads are V-shaped. The elevation of the outer ends of the dikes is about 3.3 feet, and of the top of the rock on the graded bank 12 feet above low water. The tops of the dikes slope uniformly between these two points.

The bank at the inner ends of the dikes is cleared and graded by hand to a slope of 1 on 3. This work was rendered more expensive by the necessity of removing old work put in by the railroad company. The foot mattresses were woven and sunk in advance of the pile driving. The mattresses were woven 12 inches thick. The T-heads were 60 feet by 70 feet, and the stems were 50 feet wide. The work was considerably delayed by the slow delivery of brush by the contractors. Weaving mattress for the dikes was begun at Dike 13 August 25 and was finished October 19. Foot mattresses for 23 dikes, with a total area of 142,380 square feet, were woven; 804.92 cords of brush were used. The rock for the dikes was unloaded from the cars on a switch extending from the bridge up the river bank about 900 feet, and was afterwards loaded on barges with wheelbarrows and floated to the dikes. The rock barges were handled, for the most part, by hand, as the steamboat was engaged most of the time towing brush. The rock was placed 3 inches thick on the mattress and 6 inches thick on the bank at the inner ends of the dikes. One thousand two hundred and twenty cubic yards of rock were used in ballasting mattress and 690 cubic yards in paving the bank.

White-oak piles were used for the most part in the construction of the dikes, Norway pine piles being used in the less exposed portions. Pile driving was begun at Dike 13 August 24 and continued until September 21, when the driver was taken to Yankton. The driver was brought back from Yankton October 5, and driving was resumed and continued until October 25, when the driver was again taken to Yankton. A new vulcan steam hammer, size 2, was used on the work. Pile driving was slow at first, as the pile driver was equipped with a small vertical boiler,

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which did not furnish sufficient steam for the hammer. Afterwards another small boiler was hired, and the two boilers, connected together, furnished sufficient steam. Strata of hard clay, or gumbo, was found at most of the dikes. Where these strata were encountered, it required from fifteen to forty minutes to drive each pile, while in ordinary ground each pile was driven in from three to seven minutes. Piles were driven in twenty dikes, the driver not returning from Yankton in time to drive piles in the remaining three dikes. These dikes being the least important of those projected, their completion may prove unnecessary.

In fourteen of the dikes the driver, on account of the low stage of the river, could not be taken in close enough to drive as many bents in the stems as had been intended. In all the dikes, the spaces between the inner bents of piles and the top of the rock on the bank were closed by piles, with one end fastened to one of the inner piles at the proper elevation, and the other end to a post set in the ground at the upper end of the rock.

Eighty-two mooring piles were driven to an average penetration of 22.4 feet. Three-hundred and fourteen piles were driven in the dikes to an average penetration of 27.4 feet. Seventy-two of the mooring piles were pulled by the snag boat *McPherson* and recovered. The dikes were braced with 6 by 8 inch and 4 by 8 inch white-pine lumber, bolted to the piles with three-quarter-inch screw bolts. Bracing the dikes was begun October 16 and finished November 12; 30,100 feet B. M. of lumber were used.

The work of screening the dikes was begun November 18 and finished November 30.

The cost of the dikes in detail is shown in Exhibit B.

After the completion of the work, the plant and all material not used were taken to the Sioux ice harbor. The steamer *Josie* was placed out of commission November 20.

The steamer *Pauline* arrived from Yankton with the pile driver November 16, and was engaged in towing plant and material until November 23, on which day she was taken to the ice harbor for the winter.

A new warehouse, 24 by 100 feet, was constructed at the Sioux ice harbor in November and December.

All construction work was done by hired labor.

The readings of the gauges maintained on the Upper Missouri River at Pierre, S. Dak.; Bismarck, N. Dak.; Fort Benton, Mont., and Townsend, Mont., and on the Yellowstone River at Glendive, Mont., have been platted as received; the maps on file at the Sioux City office have been catalogued and indexed, and considerable other miscellaneous office work done.

Asst. Engineer F. M. Towar was in charge of work during the first half of the year.

Very respectfully, your obedient servant,

BATHURST SMITH, *Assistant Engineer.*

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

EXHIBIT A.

Net cost of 824 linear feet of complete revetment, constructed at Sioux City, Iowa, during the fiscal year ending June 30, 1898.

Classification.	Quantity.	Cost per unit.	Cost per each item.
Material:			
Brush (including towing and inspection)....cords..	341.13	$1.765	$602.10
Rock....cubic yards..	982.03	1.363+	1,338.87
Rock....do....	542.30	1.40	758.82
¾-inch wire strand....linear feet..	20,720	.008+	163.56
Labor:			
Grading 824 linear feet....cubic yards..	6,400	.099	635.06
Weaving and anchoring mattress....square feet..	64,630	.010	655.62
Ballasting mattress and paving bank....cubic yards..	1,524.33	.676	1,030.36
Steamboat service (towing plant and material, except brush)....	.....	.....	101.77
Total....	824	6.415	5,286.16

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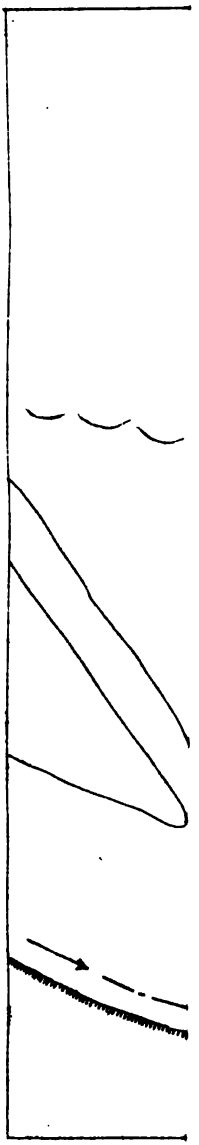

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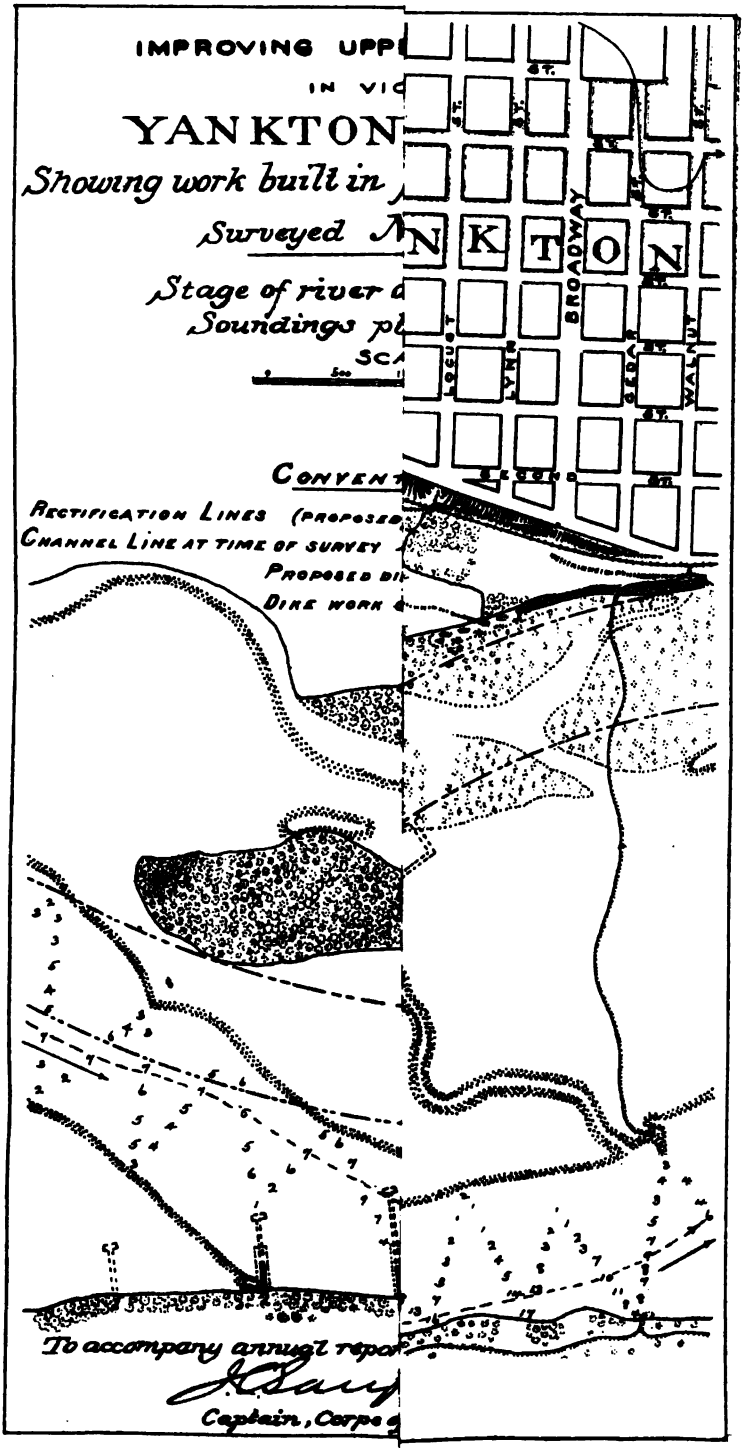

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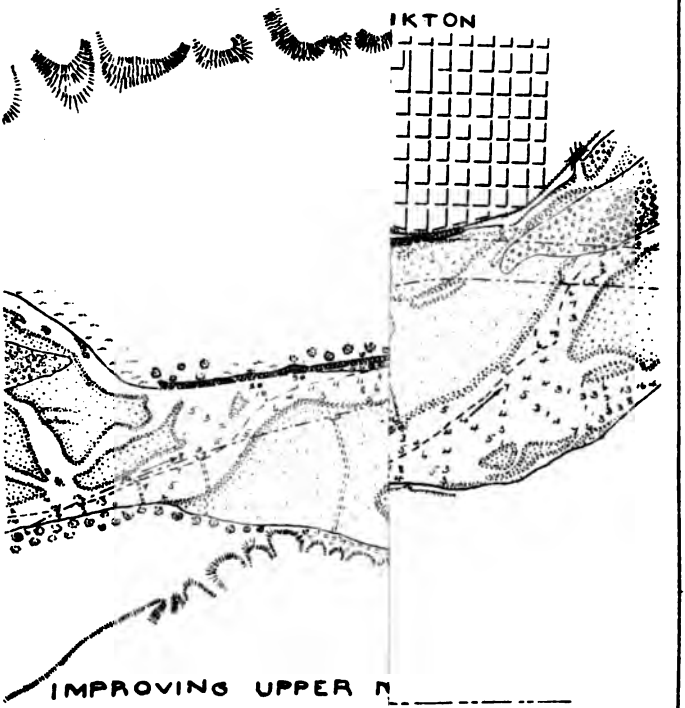

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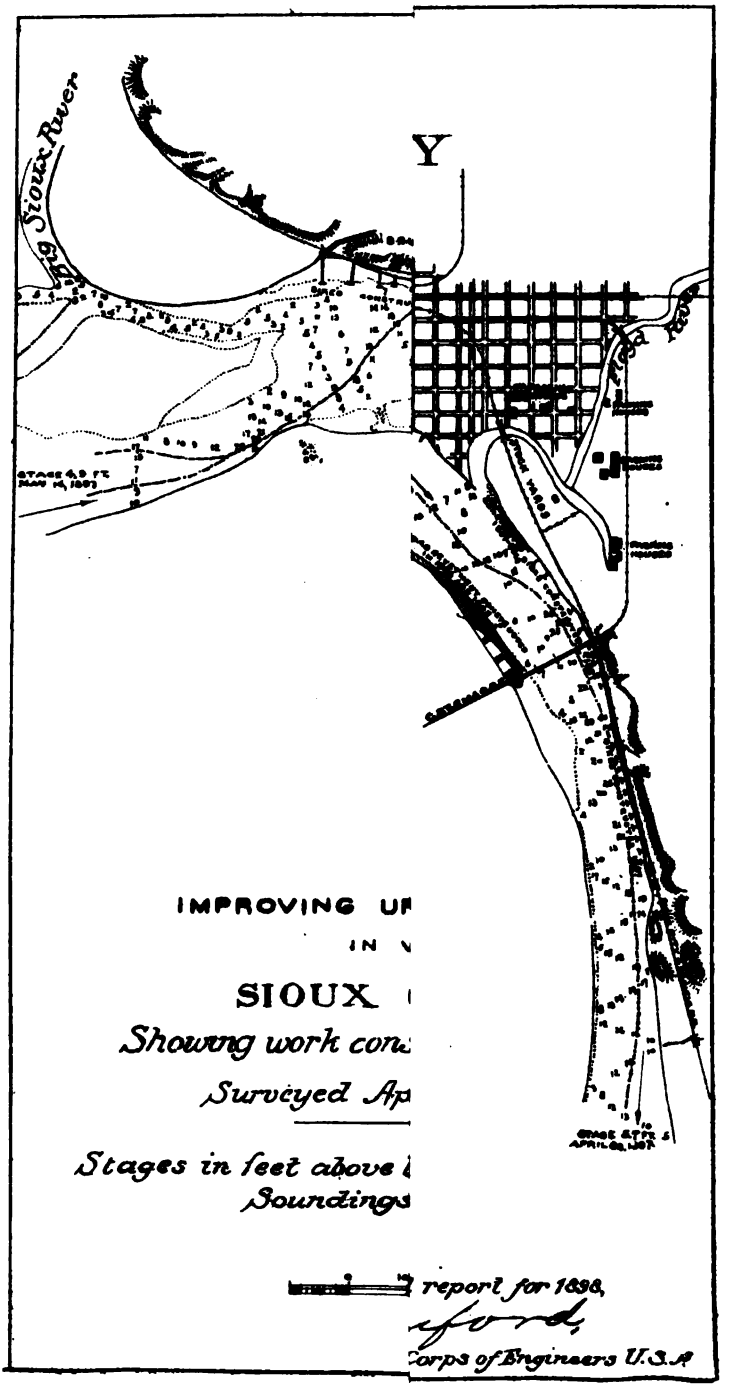

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EXHIBIT B.

Net cost of 2,046 linear feet of completed dike and 210 linear feet of incomplete dike, constructed at Sioux City, Iowa, during the fiscal year ending June 30, 1898.

Classification.	Quantity.	Cost per unit.	Cost per each item.
Material:			
354 oak piles ..... linear feet..	15,026	$0.2074	$3,116.89
56 pine piles ..... do....	2,226	.1124	250.20
Pine lumber ..... feet B. M..	30,100	19.47	586.05
Rock ..... cubic yards..	1,910	1.363	2,604.03
Brush (including towing and inspection) ..... cords..	804.92	1.765	1,420.69
Poles (including towing and inspection) ..... do....	39.23	2.535	99.46
¾-inch wire strand ..... linear feet..	43,000	.0079	339.70
¾-inch screw bolts ..... number..	1,130	.0537	60.68
¾-inch driftbolts ..... pounds..	150	.140	210.00
Washers ..... do....	150	.020	3.00
Nails ..... do....	700	.0175	12.25
Labor:			
Grading and clearing 1,320 linear feet ..... cubic yards..	31.60	.1707	539.44
Weaving and anchoring mattress ..... square feet..	142,380	.0131	1,873.38
Ballasting mattress and paving bank ..... cubic yards..	1,910	.9187	1,745.14
Driving mooring piles ..... number..	82	3.634	298.01
Driving dike piles ..... do....	314	2.510	788.18
Bracing ..... linear feet..	1,210	.536	648.31
Screening ..... do....	1,546	.120	185.50
Steamboat service (towing plant and material, except brush)	.....	.....	372.71
Total cost	.....	.....	14,945.22

B B 2.

IMPROVEMENT OF UPPER MISSOURI RIVER BY SNAGGING.

Original condition, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 337, 338, 2208, and 2209.

At the beginning of the fiscal year the *Mandan* was engaged in snagging work between Fort Yates, N. Dak., and Fort Berthold, N. Dak. The *McPherson* and *Josephine* were laid up at the Sioux ice harbor, South Dakota. Extraordinary repairs on the latter snag boat were in progress.

In August the *Mandan* made a snagging trip from Fort Yates to Pierre, S. Dak.

The repairs to the *Josephine*, which included replacing her boilers by new ones, having been completed, she left the Sioux ice harbor to replace the *Mandan* on the Fort Yates-Fort Berthold reach. She met the *Mandan*, which had started down the river, near the new Brule Agency, S. Dak., where the crews were exchanged. The *Mandan* continued down to Sioux City and was laid up at the Sioux ice harbor. The *Josephine* proceeded to Fort Yates and worked during the remainder of the season between that point and Fort Berthold. Early in November she was pulled out on the ways at the Rockhaven ice harbor. During October and the first half of November the *McPherson* worked between Sioux City and Fort Randall, S. Dak., after which she was laid up for the winter at the Sioux ice harbor.

Funds have not permitted the operation of the snag boats during the past spring. The current repairs necessary to keep them in good condition have been made.

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Summary of work of boats, July 1, 1897, to June 30, 1898.

Snag boat.	Snags removed or destroyed.	Trees felled.	Miscellaneous obstructions removed.	Miles run.	
				Up.	Down.
McPherson	91	.....	103	278	278
Josephine	99	2	42	338	323
Mandan	294	151	186	1,082	1,685
Total	484	153	331	2,298	2,286

The work has been done by hired labor and purchase of material.

WORK REQUIRED.

As the channel is constantly shifting and uncovering old snags, and as trees are, by erosion of the banks, being constantly washed into the river, forming new snags, the removing of the snags from the channel and of felling overhanging trees should of necessity be continuous, in order that the danger to navigation from these may, as nearly as possible, be removed. The work is practically one of maintenance, and should not be liable to interruption due to failure of appropriations. It is the most beneficial to navigation of any work that has been undertaken on the Upper Missouri. To properly do the work and keep in repair the three snag boats employed requires not less than $50,000 annually.

Money statement.

July 1, 1897, balance unexpended	$25,535.44
June 30, 1898, amount expended during fiscal year	23,393.34
July 1, 1898, balance unexpended	2,142.10
July 1, 1898, outstanding liabilities	897.39
July 1, 1898, balance available	1,244.71
Amount (estimated) required annually for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Amount and date of all appropriations for improving Upper Missouri River by snagging.

Allotments made from appropriations of 1890 and 1892 for improvement of Upper Missouri River	$193,073.53
March 3, 1893	50,000.00
August 18, 1894	50,000.00
June 3, 1896,	50,000.00

B B 3.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

Original condition, projects, and work done to June 30, 1897, are described in the Annual Report of the Chief of Engineers for 1897, pages 338 and 2211.

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No work has been done during the past fiscal year. The revetment at Glendive constructed in the previous year remains in good condition and has thus far protected the town front.

A reasonable probability of the early resumption of steamboat navigation between Glendive and the mouth not having yet been shown, nothing has been done toward the removal of snags and examination of shoals in this portion of the river. (See Annual Report of the Chief of Engineers for 1897, page 2211.)

Money statement.

July 1, 1897, balance unexpended	$11,771.72
June 30, 1898, amount expended during fiscal year	37.93
July 1, 1898, balance unexpended	11,733.79
July 1, 1898, outstanding liabilities	13.38
July 1, 1898, balance available	11,720.41

Amount and date of all appropriations for improving Yellowstone River.

1878 (allotment for surveys from appropriation for examination and surveys)	$15,000
1879	25,000
1880	15,000
1881	20,000
1882	20,000
1884	20,000
1886	18,750
1896	10,000
Total	143,750

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APPENDIX C C.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF OBION AND FORKED DEER RIVERS, TENNESSEE.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, LIEUT. COL. JOHN BIDDLE, UNITED STATES VOLUNTEERS, CAPTAIN, CORPS OF ENGINEERS, AND MAJ. DAN C. KINGMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Obion River, Tennessee.
2. Forked Deer River, Tennessee.
3. Cumberland River, Tennessee and Kentucky.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., July 19, 1898.

GENERAL: I have the honor to transmit herewith the annual report upon the river improvements * * * in my charge for the fiscal year ending June 30, 1898.

Very respectfully, your obedient servant,

DAN C. KINGMAN,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF OBION RIVER, TENNESSEE.

This stream is formed by the junction of the North and South forks in the western part of Tennessee, and flows in a generally southwesterly direction for about 75 miles to the Mississippi. In its course the Obion receives the overflow from Reelfoot Lake and, about 3½ miles from its mouth, the waters of the Forked Deer River.

An examination of this stream was made in 1880. (Report of the Chief of Engineers, 1881, pp. 1486–1489.) An instrumental survey was made in 1891 from the railroad bridge at Obion to the mouth of the river, a distance of 68.8 miles, having a fall of 27 feet. (Report of Chief of Engineers, 1891, pp. 2296–2301.)

The project for the improvement, based upon the survey of 1891, and the estimate of $50,000, seeks to secure at low water a navigable channel of not less than 3 feet depth between Obion, Tenn., and mouth of

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river, about 68.8 miles, by clearing the channel of snags, drift, and overhanging trees; constructing wing dams at the most obstructive shoals; straightening the very crooked channel by cutting through several sharp bends and making the cut-offs sufficiently wide and deep by clearing, grubbing, and excavating; closing the old channel by means of pile and brush dams where necessary.

On June 1, 1897, the above project and estimate were set aside or modified so as to provide simply for the work of removal of such surface obstructions as prevent navigation and for the maintenance of the channel as improved from year to year, for the reason that it was not considered possible to obtain a depth of 3 feet at low water by the methods proposed in the original project, and that the original estimated cost—$50,000—was wholly inadequate to produce the results called for.

Practically all the work done on this river has been to remove drifts, snags, overhanging trees, etc. The only satisfactory method has been to do the work at extreme low water, cut the trees, limbs, and snags, etc., into short pieces and either let them float off, or, if too heavy, drop them in deep holes. Dynamite has also been used to break up snags. Drifts and snags are, of course, constantly recurring, so that much of the river has had to be gone over again. The clearing of the river has already increased the current somewhat, thus lowering the water surface.

A channel free from snags and trees is all that can be legitimately expected. This will, however, be thoroughly satisfactory to the commercial interests on this river, as the Mississippi keeps it at a good stage for a great part of the year. The Lower Obion especially is much affected by the Mississippi River.

The amount expended upon this stream to the close of the fiscal year ending June 30, 1897, was $15,797.01, which was applied to the work of removing surface obstructions, principally drift, and has resulted in obtaining comparatively safe navigation to Obion, Tenn., the head of navigation.

All work was carried on under the hired-labor system, the only method practicable upon this stream. As a measure of economy it was found advantageous to use the same force and plant in the work of snagging upon the Obion and Forked Deer rivers. The fleet employed consisted of two quarter boats and a steam-derrick boat, with a small barge to carry away snags, logs, etc., when required. The employment of a steamboat would have been expensive, because the channel is shallow and narrow.

During the fiscal year ending June 30, 1898, $1,413.27 have been expended under the project as modified.

On October 17 the boats and working force passed out of the Forked Deer River into the Obion River and resumed the work of removing surface obstructions that prevent navigation. The snagging party, consisting of 18 men—overseer, pilot, cook, and 15 laborers—moved upstream, doing the principal work in the reach of the river about 8 miles below Obion. Work done: Snags removed, 861; snags and stumps blasted, 74; snags and trees topped, 1,629; leaning trees cut down, 669; trees deadened, 3,313; logs pinned to banks to prevent being carried into channel at high water, 905. Active operations were suspended November 30, 1897.

New boats are building for joint use upon this stream and the Forked Deer River.

The commerce of this river is principally lumber cut by sawmills now

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operating on or near this stream, and, so far as can be ascertained, the improvements have given material aid to the lumber interests involved. The product of these sawmills on the Obion River goes to all points on the Mississippi River, but as records are not generally kept of the shipments by river, the commercial statistics obtainable are limited. The commerce of the Forked Deer River passes through the lower waters of the Obion River 3½ miles, in its passage to the Mississippi.

During the season of navigation, January to May, inclusive, the steamer *James Laughlin*, drawing 5½ feet loaded, with three barges, carried 50 passengers and moved 18,263 tons of freight, principally lumber, having an estimated value of $68,500.

Money statement.

July 1, 1897, balance unexpended	$5,202.99
June 30, 1898, amount expended during fiscal year	1,413.27
July 1, 1898, balance unexpended	3,789.72
July 1, 1898, outstanding liabilities	160.60
July 1, 1898, balance available	3,629.12
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	2,500.00

Appropriations for improving Obion River, Tennessee.

Act of—	
July 13, 1892	$7,500
August 18, 1894	7,500
June 3, 1896	6,000
Total	21,000

COMMERCIAL STATISTICS.

Obion River, Tennessee, from July 1, 1897, to June 30, 1898.

	Tons.
Cattle	8
Horses and mules	5
Lumber	17,500
Wood	650
General merchandise	100
Total tonnage	18,263

Estimated value, $68,500. Passengers carried, 50.

List of steamboats (stern-wheel) plying on Obion River, Tennessee.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Clyde	50	14	2.5	10
Gracie	52	11	4.6	34.79
James Laughlin	71.5	15	4.5	28.76

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CC 2.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

I. The Forked Deer River and its navigable branches run wholly in the State of Tennessee, and are tributary to the Mississippi system.

Examinations of these streams have been made as follows:

1. Of the North Fork and Forked Deer River.—From Dyersburg to mouth of the main stream, distance about 29½ miles, made in 1873 under act of March 3, 1873. (Report Chief of Engineers, 1874, Part I, pp. 372–380.)

2. Of the South Fork.—From Jackson to junction with North Fork, distance about 149 miles; of the North Fork, from Collins to the mouth of Forked Deer River, main stream, distance about 131 miles, each made in 1880 under act of June 14, 1880. (Report Chief of Engineers, 1881, pp. 1489–1497.)

3. Of the North Fork below Dyersburg, Tenn.—Preliminary examination made in 1886 under act of August 5, 1886. (Report Chief of Engineers, 1887, pp. 1494–1495.)

4. Of the Forked Deer River.—From Dyersburg, Tenn., to its junction with the Obion River and thence to the Mississippi River, made in October, 1894, act of August 17, 1894. (Report Chief of Engineers, 1895, pp. 2265–2275.)

5. Survey of the North Fork of Forked Deer River, Tennessee.—From Dyersburg to the main stream, thence to Obion River, made in November, 1896, under act of June 3, 1896. (House Ex. Doc. No. 282, Fifty-fourth Congress, second session.)

The original condition of channel way, data pertaining to original project and estimates, expenditures, and methods of work on the main stream and its navigable branches, are discussed in Report of Chief of Engineers, 1896, page 1901 et seq.

By act of June 3, 1896, $1,000 were appropriated for "maintenance" of the improved channel of the Forked Deer River. The amount expended to June 30, 1897, was $985.36, and because the North Fork and main stream were provided for in a separate appropriation, the work done was wholly upon the South Fork as authorized, and consisted of the removal of surface obstructions from the channel for a distance of about 27 miles below Chestnut Bluff. No work was done nor expenditures made for "maintenance" during the fiscal year ending June 30, 1898.

The amount estimated as required for clearing channel and "maintenance" of the improvements effected in the Forked Deer River and its navigable branches is $3,000 annually. (Report of Chief of Engineers, 1897, pp. 2236–2237.)

Money statement.

July 1, 1897, balance unexpended	$14.64
July 1, 1898, balance unexpended	14.64
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	3,000.00

II. THE NORTH OR MIDDLE FORK OF FORKED DEER RIVER, TENNESSEE, FROM DYERSBURG TO THE OBION RIVER, AND FROM THENCE TO THE MISSISSIPPI RIVER.

The stream from Dyersburg, Tenn., to the Mississippi River, about 33 miles, is locally known as the North Fork from Dyersburg, Tenn., to its junction with the South Fork, 8½ miles; thence to the Obion River as the Forked Deer River, main stream, 21 miles; thence to the Mississippi River as the Obion River, 3½ miles, and has been heretofore so provided for under sundry appropriations.

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A survey was made of this stream from Dyersburg to the Mississippi River in 1894, and report submitted that the stream can not be made navigable "all the year by means of open-channel work," consequently no estimate nor project was made for such work. The general estimate of $400,000 was given in said report for a slack-water system of navigation. (Report of Chief of Engineers, 1895, pp. 2265–2275.)

A resurvey was made in November, 1896, under the provisions of act of June 3, 1896. It was recommended in the report submitting the same, that the improvement of the river between Dyersburg and the mouth, be confined to clearing snags, shutting off basins, closing secondary channels, and aiding in the general improvement of navigation. (Report of Chief of Engineers, 1897, pp. 2234–2242.)

By act of June 3, 1896, $5,000 was appropriated for improving the stream from Dyersburg, Tenn., to the Mississippi River, under the general name of the North or Middle Fork of the Forked Deer River, for removing bars and shoals, deepening the channel, and improving the navigation of said river; that is, channel work generally.

The project for its expenditure provides for continuing the improvement of the North Fork and the Forked Deer River—main stream—by removing snags, cypress knees, embedded logs, drift, leaning trees and other surface obstructions, including bars at the mouth of Forked Deer River and bars and shoals at other points in the channel, from Dyersburg, Tenn., to the mouth of the Forked Deer River, about 29½ miles, so as to deepen the channel and make it navigable for small craft at a 3-foot or higher stage to the Obion River and thence to the Mississippi River. This project was approved July 24, 1896.

The amount expended to the close of the fiscal year, June 30, 1897, was $1,052.94, and resulted in partially clearing the channel of snags, drift, sunken logs and trees, and surface obstructions generally, the lower reaches of the river being greatly impeded by the continuous drift accumulations, requiring explosives to remove them.

In the fiscal year ending June 30, 1898, $1,235.24 have been expended in clearing the channel, as provided by act of June 3, 1896. The disbursements are classed as follows:

Pay rolls	$920.83	Tools, rope, etc	$57.39
Traveling expenses	21.55	Repairs of boats and machinery	49.86
Transportation and hauling	1.85	Miscellaneous	12.95
Subsistence	117.07		
Fuel, lights, etc	8.74	Total	1,235.24
Explosives	45.00		

Necessary repairs of boats and machinery were begun August 9 and completed August 27. Work of removing surface obstructions from the channel of the North Fork was begun at Dyersburg September 4, reaching the main stream September 18; thence work was continued down the Forked Deer River, reaching the Obion River on October 16. The boats and working force entered the Obion on October 17 and began operations upon that river, it having been found to be economical and advantageous to use the same working force and plant upon both streams.

Work done.—Total length of channel worked over, 29½ miles; 1,485 snags and 11 cords of drift removed; 25 snags and 45 stumps blasted; 1,278 snags topped; 57 leaning trees cut down; 111 trees deadened; 1,222 logs, scattered along the banks, disposed of—663 cut up and removed and 559 pinned to the banks to prevent being washed into the channel at high water.

Action has been taken to obtain timber, etc., having in view the

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building of a new derrick boat and new quarter boat for use upon the Forked Deer and Obion rivers, the present boats being unserviceable.

The commerce to be benefited consists principally of rafting logs and moving lumber to and from sawmills. Some live stock and general merchandise also reach a market by way of the river.

The commerce during the fiscal year, so far as could be ascertained, aggregated 21,363 tons, having an estimated value of $71,000. Passengers carried, 68.

Money statement.

July 1, 1897, balance unexpended	$3,947.06
June 30, 1898, amount expended during fiscal year	1,235.24
July 1, 1898, balance unexpended	2,711.82

Appropriations for improving Forked Deer River, Tennessee, and its navigable branches.

By act of—	
August 2, 1882, for South Fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888, for South Fork	2,500
August 11, 1888, for North Fork	4,500
August 11, 1888, for main river	2,500
September 19, 1890, for North Fork and main river	2,500
July 13, 1892, for Forked Deer River (completing improvement)	3,000
Total, to complete project	25,000
June 3, 1896, for Forked Deer River (for maintenance)	1,000
June 3, 1896, for North or Middle Fork, from Dyersburg to Mississippi River	5,000
Total appropriated	31,000

COMMERCIAL STATISTICS.

Forked Deer River, Tennessee, from July 1, 1897, to June 30, 1898.

	Tons.
Cattle	8
Horses and mules	5
Lumber	18,250
Wood	3,000
General merchandise	100
Total tonnage	21,363

Estimated value, $71,000. Passengers carried, 68.

List of steamboats navigating Forked Deer River, Tennessee.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
James Laughlin	71.5	15	4.5	28.76
Mary Louisa	51	16	3	39.90

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C C 3.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

A description of this stream and of the character of its obstructions generally, with a statement as to efforts made for its improvement from 1830 to 1840, also a detailed statement of the examinations and surveys made by the United States from 1870 to 1880, which formed the basis under which work was carried on until the adoption of the present projects for improvement below and above Nashville, are given in Report of Chief of Engineers, 1896, page 1905 et seq.

The original project provides for channel work as follows:

To excavate the bars and rock ledges to get an additional depth of water, to contract the waterways in places to get the requisite depth, to remove snags and bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

To increase the depth of water at the shoals at the junction of the Cumberland River with the Ohio River, a Board of Engineer Officers recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600. (Report of Chief of Engineers, 1888, pp. 1626–1632.) The river and harbor act of September 19, 1890, allotted $30,000 from the appropriation for improving Cumberland River below Nashville, to be expended in improving the mouth of the river as recommended.

The dike as at present constructed, however, secures the object sought after; that is, the passage from the Cumberland River to the Ohio. Bars form in the Ohio River opposite the mouth beyond the end of the dike. These bars shift continually, but there has never been any difficulty in passing from one river to the other since the dike has been completed, while previously the mouth was often closed while each river remained navigable. It seems probable that some time the gap in the dike will have to be protected. With that in view, and also to ascertain effect of dike, surveys have been made each year to determine the changes that occur. Up to the present, no cutting of the towhead has taken place. It is suggested that if this happens it would be well to cover the gap with a layer several feet thick of broken stone extended in front of the line of the dike, so that as the bank cuts away the stone will fall in and make a protection. It is also possible that Cumberland Island will have to be further protected.

The present condition is, however, that for an expenditure of $23,716.71 the results sought for under a project estimated at $129,600 have been obtained.

A resurvey of the mouth of the river was made in November, 1896, under the provisions of act of June 3, 1896. (House Doc. No. 283, Fifty-fourth Congress, second session.)

Under the old project and estimates, thirteen appropriations were made from 1871 to 1890, aggregating $305,000, the expenditure of which in open-channel work has resulted in lengthening the season of navigation, by giving an increased depth at low water, combined with greater security in the passage of various obstructions.

A resurvey of the mouth of the river was made in November, 1896, under the provisions of act of June 3, 1896. (Report of Chief of Engineers, 1897, pp. 2242–2245.)

The existing project for improving the river below Nashville consists of (1) the extension of the lock and dam system of the Upper Cum-

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berland to the lower river, by the construction of 7 locks and dams, extending from near the mouth of Harpeth River (Lock A) to Big Eddy Shoals (Lock G), the lock chambers to be each 280 feet available length by 52 feet width, the lifts of the locks varying from 8½ to 11½ feet, aggregating about 70 feet; (2) of the improvement of the Kentucky Chute at mouth of river, as recommended by Board of Engineer Officers June 16, 1888 (Report of Chief of Engineers, 1888, p. 1628); (3) of the channel work necessary below lock G, between Big Eddy Shoals and mouth of river, and (4) snagging and removal of surface obstructions below Nashville. Total estimate of cost of entire improvement, $1,964,500. (Report of Chief of Engineers, 1890, pp. 2151–2161.)

Three appropriations have been made for this work under the present project, aggregating the sum of $150,000.

The act of July 13, 1892, appropriated $40,000 for continuing the improvement, including the mouth of the river. This item forms the initial appropriation for operations under the project or plan above stated.

Harpeth Shoals are the most formidable obstruction to the navigation of the Lower Cumberland, and to overcome this obstacle the present project has in view that the lock and dam near the mouth of Harpeth River, 41½ miles below Nashville, be pressed to completion as rapidly as possible.

The total amount expended under the present project at the close of the fiscal year ending June 30, 1897, was $63,140.67. These funds were applied at Lock A to the purchase of sites for lock and abutment of dam; the erection of temporary buildings for employees, storehouses, etc., and the construction of cofferdam 700 feet long, with riprap at junction at bank; the excavation in part of lock chamber; clearing sites, right of way, and bank at lock approaches; building landing pier, tramway, and gravity incline for moving stone; opening and stripping quarries, quarrying and moving stone to lock site. The examination of river banks and selection of sites for lock and abutment of Dam B, the second lock of the series below Nashville, was also made. The lock site is on the left bank near Hollingsworth Landing, about 51 miles below Nashville. The proposed sites will be submitted as soon as maps of same are completed. The funds were also used in the work of removing surface obstructions from the channel below Nashville.

During the fiscal year ending June 30, 1898, $52,465.66 were expended. The disbursements are classed as follows:

Pay rolls, office	$3,708.16
Pay rolls at works	39,798.94
Temporary buildings	30.80
Traveling expenses and mileage	151.90
Masonry	540.11
Lands	393.60
Fuel, lights, etc	897.48
Subsistence	2,893.88
Office and post-office rents	423.00
Office fixtures and stationery	97.66
Machinery and repairs	1,071.37
Boats, barges, and repairs	1,535.13
Rope, tools, etc	405.52
Tramway	33.35
Explosives	144.20
Transportation and hauling	60.13
Miscellaneous	280.43
Total	52,465.66

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These funds were applied to stripping quarry, quarrying, and cutting stone for masonry of lock, moving stone from quarry to lock site, and scabbling stone for backing. A large amount of miscellaneous work was necessarily done, consisting principally of surfacing and laying tram track and incline; repairing turntables, tram cars, and machinery; making scaleboards and tram-car brakes; placing steam derricks and motive power for same in position; sloping and riprapping bank; covering and concreting cistern, etc. Details as to the method of carrying on operations, general cost of same, statement of the work done, and the unit prices are submitted in the appended report of Asst. Engineer J. S. Walker, who has been in local charge of the operations on the Cumberland River, above and below Nashville, for more than seven years, to which report reference is respectfully invited.

On April 21, 1898, an additional tract of land—13.55 acres—abutting on the lock site, was bought by and conveyed to the United States whereon to erect suitable buildings for quarters of employees, the health of the camp demanding that it be established on higher ground than at first chosen.

No work in channel has been carried on during the fiscal year.

By authority a new hull (130 feet by 24 feet by 3.9 feet) was constructed for the U. S. S. *Weitzel*, the machinery thoroughly repaired, necessary new machinery and fittings supplied, and all placed in position on the new hull, together with an electric plant of sufficient capacity to thoroughly light the boat. The steamer has been renamed and will be reported hereafter as the *Cumberland*. The cost of the construction ($9,600) will be divided and paid for equally from the appropriations for improving Cumberland River below Nashville, Tenn., and above Nashville, Tenn. The U. S. S. *Cumberland* was built by E. J. Howard, of Jeffersonville, Ind., and accepted June 25, 1898.

The balance of the funds appropriated being inadequate, from an economical standpoint, to justify the laying of the limited quantity of masonry in the lock walls that could be done with the money now available, it was recommended by my predecessor in charge of the work that instead of laying the lock walls the abutment of the dam should be built by hired labor and the purchase of materials, in accordance with existing regulations. This plan was approved by the Chief of Engineers, May 19, 1898, and work upon the abutment will be commenced early in the next fiscal year.

The work done under the present project has not actually increased the availability or adaptability of the improvement for the purposes of commerce, and it can not be so increased until Lock A is completed and operated.

The cost of maintenance of the river below Nashville in its present condition is estimated at about $5,000 per annum. As each lock is completed the cost will be increased from $4,000 to $6,000 per lock. When the whole system of six locks is completed, including the channel work to be done each year below the locks, and to maintain connection with the Ohio River, the probable cost of maintenance will be about $50,000 per annum.

The commerce of the Lower Cumberland River, so far as could be ascertained, aggregated 71,674 tons, having an estimated value of $7,788,530.

The estimate of cost of improving Cumberland River, below Nashville, in accordance with existing project	$1,964,500.00
Amount appropriated under existing project	150,000.00
Amount expended under existing project	115,606.33

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Money statement.

July 1, 1897, balance unexpended	$86,859.33
June 30, 1898, amount expended during fiscal year	52,465.66
July 1, 1898, balance unexpended	34,393.67
July 1, 1898, outstanding liabilities	6,147.25
July 1, 1898, balance available	28,246.42
Amount (estimated) required for completion of existing project	1,814,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

2. ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

A general description of the Upper Cumberland, from Nashville to Cumberland Ford (Pineville), and of the character of its obstructions, the seven appropriations made from 1876 to 1884 for its improvement in specified sections, aggregating the sum of $346,000, are given in Report of Chief of Engineers, 1896, pages 1907, 1908.

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel by excavation over the worst shoals, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

FROM NASHVILLE TO THE HEAD OF SMITH SHOALS, MOUTH OF ROCKCASTLE RIVER, 357 MILES.

The instrumental surveys of 1882 and 1883, with accompanying estimates (Report of Chief of Engineers, 1884, p. 1663 et seq.), furnish the basis of the present project for the radical improvement of the Cumberland River above Nashville.

The project originally provided for the construction of 23 locks and dams between Nashville, Tenn., and Burnside, Ky., and of 7 locks and 2 dams at Smith Shoals, using the river itself as a canal, 1 dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922. The project stated that the 23 locks between Nashville, Tenn., and Burnside, Ky., "should be about 60 feet wide and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose" (Report, Chief of Engineers, 1884, p. 1664), and that the dimensions of the 7 locks at Smith Shoals were to be "55 by 140 feet in the chamber." (Report, Chief of Engineers, 1882, p. 1864.)

This project was modified by enlarging the locks to 280 feet long by 52 feet wide, and having from 10 to 12 feet lift, and by increasing the channel depth to 6½ feet, thus providing for a minimum navigation of 6 feet instead of 4 feet, and further by reducing the number of locks in the Smith Shoals section to 6. (Reports of Chief of Engineers, 1888, p. 1623; 1891, p. 2270.)

The present project, therefore, provides for the radical improvement of the river from Nashville to the head of Smith Shoals, mouth of Rockcastle River, Kentucky, 357 miles, by a complete system of lockage, consisting of 30 locks and dams, if this number be necessary, 23 below Burnside, Ky., and 6 above that point (the Smith Shoals system), with

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a view to secure a minimum channel depth of 6 feet, locks to be 280 feet long, 52 feet wide, and from 10 to 12 feet lift, at an estimated cost of $8,500,000. (Report of Chief of Engineers, 1896, p. 1916.)

The act of June 3, 1896, provides for the completion of the whole or any part of locks numbered 5, 6, and 7 under the continuing contract system, or otherwise than by contract, not to exceed in the aggregate $600,000, subject to the limitations as to payments enacted in section 5 of said act. The sundry civil act of June 4, 1897, appropriates the sum of $350,000 to meet payments incurred within the limits authorized by law on account of Locks Nos. 5, 6, and 7.

The act of June 3, 1896, appropriates $20,000 for purchasing sites for Locks and Dams Nos. 21 and 22, in Kentucky, and for laying masonry for the same. In the interests of the improvement generally, it is preferable that the masonry of Lock No. 21 be first pressed to completion; therefore the amount available, after paying for the sites required for both locks and abutments of dams, can be best applied in clearing sites, building cofferdam, and preparing foundation for the walls of Lock No. 21, and in payment of the contingent expenses pertaining to the work.

Seven appropriations have been made for this work under the present project, aggregating the sum of $1,345,000.

The amount expended under the existing project to the close of fiscal year ending June 30, 1897, was $932,019.15, of which sum $19,366.44 were expended on the Smith Shoals section. The application of this expenditure is set forth in Reports of the Chief of Engineers, 1896, pages 1912–1915, and 1897, pages 2225–2227.

The amount expended under the present project during the fiscal year ending June 30, 1898, was $144,891.34, as follows:

General improvement	$14,824.09
Locks Nos. 21 and 22	993.16
Smith Shoals section	886.50
Locks Nos. 5, 6, and 7, continuous contracts or otherwise, as provided by river and harbor act June 3, 1896, and sundry civil act June 4, 1897	128,187.59
	144,891.34

These disbursements have been classed as follows:

General improvement:		
Lock No. 1	$68.50	
Lock No. 2	520.16	
Lock No. 3	306.95	
Lock No. 4	320.82	
Lock No. 5	9,655.34	
Lock No. 7	140.00	
Channel work	301.89	
Steamer *John Phœnix*	142.09	
Steamer *Susette*	138.77	
Steamer *Weitzel*	479.93	
Steamer *Cumberland*	635.81	
General expenses	2,113.83	
		$14,824.09
Locks and Dams Nos. 21 and 22:		
Lock No. 21	133.20	
Lock No. 22	859.96	
		993.16
At Smith Shoals		886.50
Locks 5, 6, and 7:		
Lock No. 5	33,892.58	
Lock No. 6	31,797.65	
Lock No. 7	60,711.65	
Steamer *Susette*	1,785.71	
		128,187.59
Total		144,891.34

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Lock No. 1 (*2.5 miles below Nashville*).—Masonry of lock completed September 2, 1892, and abutment of dam completed November 18, 1893. No work was done during the fiscal year other than watching and taking care of lock keeper's house and the engineer property.

Lock No. 2 (*9 miles above Nashville*).—Masonry of lock completed October 26, 1896. Active operations suspended June, 1897. No work done during the fiscal year other than watching the engineer property stored at the lock.

Lock No. 3 (*26 miles above Nashville*).—Masonry of lock completed August 15, 1895, and active operations suspended. Engineer property stored at lock in care of watchman.

Lock No. 4 (*44.75 miles above Nashville*).—Masonry of lock finished April, 1895. Active operations suspended August, 1895. Engineer property stored at lock in care of watchman.

Lock No. 5 (*72 miles above Nashville*).—Operations were carried on during the entire fiscal year. In July and August the work was largely of a miscellaneous character—moving machinery and building temporary protection over same, prospecting for quarries, clearing United States lands, etc. In September the lock pit was pumped out and excavation and laying of concrete in the lock chamber were begun. Concreting was finished in October, 638.4 cubic yards being laid. The laying of the masonry was begun on October 19 and continued until November 24, when all available stone—2,094 cubic yards—was placed in the lock walls. The quarry selected and worked lies on the slope of bluff on the right bank of river, and agreement has been made with the owner to pay 2½ cents per cubic yard for all stone quarried and removed by the United States. Six thousand eight hundred and eighty-eight and twenty-four one-hundredths cubic yards of stone suitable for masonry have been quarried, of which 3,256.24 cubic yards have been boated to the lock site, and 1,789.21 cubic yards have been cut. The U. S. S. *Weitzel*, *John Phœnix*, and *Susette* were employed towing stone from quarry, moving heavy supplies, coal, lumber, machinery, etc., from Nashville to Lock No. 5, and other points where work of lock construction was in progress.

A new hull was built for the U. S. S. *Weitzel*. Its dimensions are, length 130 feet, width 24 feet, depth 3 feet 9 inches. The building of the hull, transferring, repairing, refitting, and placing all machinery in position, together with an electric plant of sufficient power to thoroughly light the boat, cost the lump sum of $9,600, complete. The boat has been renamed the *Cumberland*, and was completed and accepted June 25, 1898, after a thorough inspection and successful trial trip.

The total amount expended during the fiscal year on account of Lock No. 5 is $43,547.92, of which sum $9,655.34 were paid from appropriations for general improvement and $33,892.58 were paid from the appropriation of $350,000 made in the sundry civil act of June 4, 1897, for the completion of the whole or any part of Locks Nos. 5, 6, and 7, above Nashville, under the provisions of the continuous contract system, or otherwise than by contract. Under the approved project for the expenditure of the $350,000 it is provided that $90,000 be allotted to Lock 5 and $260,000 to Locks 6 and 7, equally divided.

The work at Lock 5 has been done by the United States by hired labor and the purchase of supplies under existing regulations.

Lock No. 6 (*89.6 miles above Nashville*).—The construction of the lock has been carried on under the continuous contract system. The contractor is the firm of McArthur Bros. Co., of Chicago, Ill. Contract dated May 4, 1897. Prices paid are given in Report of Chief of Engineers, 1897, pages 2230–2231. Work done during the fiscal year: Earth

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excavation, 993.7 cubic yards; rock excavation, 1,447 cubic yards; approach excavation, rock, 1,106.1 cubic yards; stone filling, 556 cubic yards; stone inspected and accepted at lock site, cut stone of all classes, 1,579.9 cubic yards; backing, 1,881.8 cubic yards. Advance payment has been made upon this stone, excepting on that received in June. Total value of indebtedness incurred under this contract during the fiscal year, $37,708.34; amount paid, $29,063.81. Of the $350,000 appropriated by the sundry civil act of June 4, 1897, the sum of $130,000 is to be applied to payments under this contract.

Lock No. 7 (106.6 miles above Nashville).—The small tract of land (thirty-six one-hundredths of an acre) needed to complete the abutment site, and lying upon Chambers Island, was acquired and title vested in the United States by payment into the United States court of $32.40 on April 11, 1898. The construction of the lock has been carried on under the continuous contract system. The contractor is the McArthur Bros. Co., of Chicago, Ill. Contract dated May 4, 1897. Prices paid are given in Report of Chief of Engineers, 1897, pages 2230–2231. Work done during the fiscal year: Earth excavation, 768.65 cubic yards; stone filling, 640.3 cubic yards; stone inspected and received at lock site, cut stone of all classes, 2,946.41 cubic yards; backing, 6,701.55 cubic yards. Advance payments have been made upon this stone, excepting on that received in June. Total value of indebtedness incurred under this contract during the fiscal year, $68,766.34; amount paid, $57,785.20. Of the $350,000 appropriated by sundry civil act of June 4, 1897, the sum of $130,000 is to be applied to payments under this contract.

Details as to the character of quarry, methods of carrying on operations, kind of plant used, amount of work done, and its cost at Locks 5, 6, and 7 are given in the appended report of Assist. Engineer J. S. Walker, under whose economical and efficient management the work is progressing, and to which report reference is respectfully invited.

Lock No. 8 (125.25 miles above Nashville).—Sites for lock and abutment of dam have been approved. The abutment site will be acquired by voluntary purchase. Title and form of conveyance is under consideration of the Department of Justice. Efforts are making to obtain the lock site by voluntary purchase, otherwise to acquire the site by condemnation in the United States court.

Lock No. 21, in Kentucky (296.25 miles above Nashville and 28.75 miles below Burnside, Ky.).—The lands for sites of lock and abutment of dam have been condemned. Final action of the Department of Justice as to title has not yet been taken.

Lock No. 22 (320.25 miles above Nashville and 4.75 miles below Burnside, Ky.).—The sites for lock and abutment have been acquired by the United States. In view of the small amount of funds available for Locks Nos. 21 and 22 ($18,593.79), and in the interest of the work generally, it is preferable, after paying for the sites for both locks, that the masonry of Lock No. 21 be completed before beginning work on Lock No. 22.

In May and June the snag boat was repaired and refitted and preliminary action taken having in view the clearing of channel of surface obstructions below Burnside, but by reason of low stage of water the boats were unable to start to the head of navigation as intended, in order to work downstream.

Smith Shoals, Kentucky.—The improvement of these shoals by locks and dams forms a part of the existing project for the canalization of the river above Nashville, the Smith Shoals system consisting of seven locks and dams between Burnside, Ky., and mouth of Rock Castle River. (Report Chief of Engineers, 1891, p. 2270.) It has been ascer-

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tained that the seven locks will not be necessary, owing to an increase of lift in the other locks, which is rendered advisable by reason of the small river discharge at low water not permitting of any material loss during the season of navigation; also simplicity of operation and maintenance at the rather inaccessible locations necessarily selected for the lock sites. The project has therefore been modified, reducing the number of locks to six; modification approved August 12, 1895.

Amount allotted "at Smith Shoals," act of September 19, 1890		$50,000.00
Less amount made available for expenditure under the approved project for the general improvement of Cumberland River above Nashville, Tenn., by authority of Secretary of War, September 1, 1886		30,000.00
		20,000.00
Amount allotted "above Burnside," act of July 13, 1892		5,000.00
Amount allotted "above Burnside," act of August 18, 1894		5,000.00
Total allotted		30,000.00
Amount expended to June 30, 1897	$19,366.44	
Amount expended during fiscal year ending June 30, 1898	886.50	
Total expended		20,252.94
Balance available July 1, 1898		9,747.06

The allotments by act of July 13, 1892, and August 18, 1894, provided that $5,000 of each of said general appropriations may be used in the improvement of the river above the town of Burnside. It was recommended and approved that these sums be applied to the Smith Shoals system of lockage, as projected "above Burnside."

The sites for the six locks and abutments of dams have been approved and authority granted to acquire the lands by voluntary purchase, or by condemnation if necessary.

During the present fiscal year the abstracts of title heretofore obtained have been brought up to April 18, 1898. These abstracts cover the titles to all the lands required for sites for locks and abutments of Dams Nos. 1 to 6, inclusive.

So far as reports have been received, the commerce of the Upper Cumberland River below Burnside during the fiscal year ending June 30, 1898, aggregated 89,776 tons, having an estimated value of $4,122,900.

Estimate for improving Cumberland River from Nashville to head of Smith Shoals, mouth of Rockcastle River, Kentucky, under project for canalization	$8,500,000.00
Amount appropriated	1,345,000.00
Amount expended to June 30, 1898	144,891.34
Outstanding liabilities	9,483.36
Amount covered by uncompleted contracts to June 30, 1898	173,150.99

Money statement.

July 1, 1897, balance unexpended		$412,980.85
June 30, 1898, amount expended during fiscal year		144,891.34
July 1, 1898, balance unexpended		268,089.51
July 1, 1898, outstanding liabilities	$9,483.36	
July 1, 1898, amount covered by uncompleted contracts	173,150.99	
		182,634.35
July 1, 1898, balance available		85,455.16

Amount (estimated) required for completion of existing project	7,155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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APPROPRIATIONS.

Improving Cumberland River, Tennessee and Kentucky, general river, 1832 to 1838.

Act of—	
July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

Improving Cumberland River below Nashville, Tenn.

[Under old projects for open-channel work, from 1871 to 1890.]

Act of—		Act of—	
March 3, 1871	$30,000	August 5, 1882	$15,000
June 10, 1872	20,000	July 5, 1884	7,500
March 3, 1873	25,000	August 5, 1886	12,500
March 3, 1875	25,000	August 11, 1888	10,000
June 18, 1878	45,000	September 19, 1890	40,000
March 3, 1879	40,000	Total	305,000
June 14, 1880	20,000		
March 3, 1881	15,000		

[Under new project for locks and dams, from 1892 to 1897.]

Act of—	
July 13, 1892	$40,000
August 18, 1894	30,000
June 3, 1896	80,000
Total	150,000

Improving Cumberland River above Nashville, Tenn., under original projects for open-channel work, from 1876 to 1884.

Geographical division.	Act of—			
	Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.
1. Nashville to Kentucky line	$15,000	$20,000	$18,000	$15,000
2. Kentucky line to Smith Shoals	10,000	8,000	6,000	10,000
3. Smith Shoals	25,000	30,000	15,000	20,000
4. Smith Shoals to Falls of Cumberland	2,000	2,000		
Total	52,000	60,000	39,000	45,000

Geographical division.	Act of—			Total.
	Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	
1. Nashville to Kentucky line	$15,000			$83,000
2. Kentucky line to Smith Shoals	15,000			49,000
3. Smith Shoals	10,000	$15,000		115,000
4. Smith Shoals to Falls of Cumberland				4,000
5. Above mouth of Jellico, Kentucky	10,000	5,000		15,000
6. Nashville to Smith Shoals		30,000		30,000
7. Nashville to head of Smith Shoals			$50,000	50,000
Total	50,000	50,000	50,000	346,000

Improving Cumberland River above Nashville, Tenn., under the present project for a system of locks and dams, from Nashville, Tenn., to head of Smith Shoals, mouth of Rockcastle River, Kentucky.

Act of—		Act of—	
August 5, 1886	$75,000	June 3, 1896	$20,000
August 11, 1888	200,000	June 4, 1897 (sundry civil act)	350,000
September 19, 1890	250,000		
July 13, 1892	250,000	Total	1,345,000
August 18, 1894	200,000		

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List of contracts in force during the fiscal year ending June 30, 1898, for improving Cumberland River above Nashville, Tenn.

No.	Name and address of contractor.	Purpose.	Date entered into.	Date of approval.	Date of beginning work.	Date of expiration.
1	McArthur Bros. Co., Chicago, Ill.	Construction of lock and abutment of dam No. 6.	May 4, 1897	June 22, 1897	June 3, 1897	May 1, 1899
2	.....do	Construction of lock and abutment of dam No. 7.	.....do	.....do	July 12, 1897	Do.

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from July 1, 1897, to June 30, 1898.

Articles.	Tons.	Articles.	Tons.
Brick	504	Salt	4,930
Cattle	953	Sand	6,000
Coal	2,200	Shingles	150
Flour	710	Staves	50
Grain	19,413	Tobacco	6,050
Hay	1,980	Wood	1,600
Horses and mules	7,805	General merchandise	13,379
Hogs	800		
Iron	2,400	Total tonnage	71,674
Lumber and logs	2,750		

Estimated value, $7,788,530.
Passengers carried, 16,085.

Cumberland River above Nashville, Tenn., from July 1, 1897, to June 30, 1898.

Articles.	Tons.	Articles.	Tons.
Brick	330	Lumber and logs	58,170
Cattle	320	Salt	380
Coal	4,971	Sand	12,000
Flour	505	Shingles	77
Grain	2,045	Tobacco	610
Hay	1,610	Wood	400
Horses and mules	145	General merchandise	7,446
Hogs	539		
Irons and machinery	228	Total tonnage	89,776

Estimated value, $4,122,900.
Passengers carried, 2,930.

List of steamboats (stern-wheel) plying on the Cumberland River, Tennessee and Kentucky, June 30, 1898.

Name.	Registered dimensions.			Net tonnage.
	Length.	Breadth.	Depth.	
	Feet.	*Feet.*	*Feet.*	
A. L. Goldberg	129	20	3	58
Bob Dudley	160	29	3.8	159
Bessie Smith	127	25	2.8	50
Eleanor	63	16	3.4	33
Huntsville	125	24	4	89
Hattie McDaniel	90.5	18	2.5	67
H. W. Buttorff	160	30	4.1	160
Ida	66	17	3.5	15
J. B. Horton (side wheel)	65	14	4	32
Jas. N. White	147	27	3	77
John Orm No. 3	95	17	3.5	95
John T. Carson	85	18.8	3	47
John W. Thomas	160	26.5	4.2	158
R. Dunbar	160	29.4	6.4	158
Rock City	110	24	3.8	54
Sycamore	103.6	20.3	3	69
W. J. Bryan	100	18	4	46
Tennessee	175	32	5	.....

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REPORT OF MR. J. S. WALKER, ASSISTANT ENGINEER.

NASHVILLE, TENN., *July 1, 1898.*

MAJOR: I have the honor to submit the following report on improving the Cumberland River, Tennessee and Kentucky, for the fiscal year ending June 30, 1898:

During the year operations have been carried on at Lock A (below Nashville), Lock No. 5, Lock No. 6, and Lock No. 7 (above Nashville).

I. Below Nashville (at Lock A, 41.50 miles below Nashville).—Operations carried on by hired labor have been confined to quarrying and cutting stone for masonry of lock and abutment, repair and maintenance of plant, bank protection, cementing cistern, and fabrication of line hooks for Locks A, 5, 6, and 7, and, as a measure of economy, the fabrication of irons for snag boat on the Obion River.

At the beginning of the fiscal year the quarry had been opened, tramway and gravity incline plane built, and traveler and derricks erected. The plant used here, consisting of 9 stiff-leg derricks with 50-foot masts and 65-foot booms, steam traveler with 40-foot bridge and trestle 400 feet long, 24 feet high, and capable of storing 4,000 cubic yards of stone, 8 American Hoist and Derrick Company's 6½-inch by 10-inch double-cylinder, double-drum hoisting engines, 6 portable boilers, 2 stationary engines, 2 centrifugal pumps, 2 duplex pumps, 24 tram cars, and rails for 4,500 feet of tram track, was originally purchased for the construction of Lock No. 3 and used there until the completion of the masonry of that lock, then transferred to Lock No. 2 and used there until the completion of the masonry of that lock, then transferred to Lock A, in the winter of 1897, where it has since been used. The plant has been kept in good order and is now in good, serviceable condition. The timbers of the derricks show more signs of weakness than any other part of the plant. With long timbers, such as are used on these derricks, it is not thought that the life of such timber can be prolonged beyond five or six years without too much danger to those working around the derricks. Realizing this, a supply of new derrick timbers has been laid in and is now protected from the weather.

The quarry is located about 2,000 feet from the river at the foot of the first slope above the river bluff, and is 135 feet above the bottom land of the United States lands where the stone yard is located. There has been much waste stone quarried, but provision was made in opening the quarry to dispose of the stripping and waste, so the quarry has been kept clean and open. During the fiscal year 18,509 cubic yards of material have been taken from the quarry, at a total cost of $13,338.90 for labor and material (supplies), from which were obtained 9,444 cubic yards of stone suitable for masonry, paving, dam filling, riprap, etc., which cost $1.41 per cubic yard. Of the stone quarried, from 20 to 25 per cent is generally stone which may be cut into pointed face and special stone, 35 to 40 per cent may be cut into backing, and the balance is suitable for paving, dam filling, riprap, etc. The lay of the land is extremely favorable for storing the inferior classes of stone. The stone as brought from the quarry was very rough, and, as it was bought by the cubic yard, an accurate estimate of quantity taken was necessary. A platform scale was installed at the head of the gravity incline plane and every car going down the plane was run over these scales and weighed, and in this way a far more trustworthy estimate of quantity was made than would have been possible by measurement, and at a much less cost.

The cutting yard is located on the bottom land belonging to the United States. The stone is cut under three derricks, and the cut stone is piled under the traveler, being assorted so that no extra handling will be required when it is taken out to be laid in the wall. Communication is had between the quarry and stone yard by means of a tram track (3-foot gauge) from the traveler to the foot of the bluff, thence by a double-track gravity incline plane, 430 feet long and rising 130 feet, thence by a tram track (3-foot gauge) 1,000 feet long to the quarry. The gravity incline plane consists of two tracks, each of 5-foot gauge, with a cradle car on each track. The cradle cars are each connected to a horizontal drum by means of seven-eighths inch steel-wire hoisting rope. The drum revolves on its horizontal axle, and the two ropes, attached, respectively, to the cradles containing the empty and loaded cars, coil and uncoil on it alternately. The drum is made of a 5-inch round steel axle, two brake pulleys—one at each end—and a flat pulley midway between them. The pulleys are lagged with 4-inch by 6-inch oak; the diameter of the drum is 4 feet; the brake pulleys are 5 feet in diameter on brake circles. A band brake, lined with sugar maple, placed at each end, enables the operator to have complete control over the cradles at all times. So far, there has been no trouble with the incline; it has worked smoothly and satisfactorily. Two hundred and eighteen cubic yards of stone have been passed down the incline plane within nine hours; 125 cubic yards are passed down in eight hours with ease; the capacity of the incline plane being limited by the number of cars in use and ability to get the cars to and away from the incline plane.

It costs 27 cents per cubic yard to transport the stone from the quarry to the stone yard. As the stone was brought into the stone yard it was distributed and

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piled in three classes: First, stone to be cut into pointed face; second, stone to be scabbled into backing; third, stone for dam filling, paving, riprap, etc. The derricks and tracks in the yard are arranged for the economical handling of the stone. The stonecutters worked under the derricks. Cost of cutting each piece of stone was kept by means of cards, and those stonecutters who failed to keep up with a fair average were dropped. The system worked well. The stone as brought from the quarry was very rough and required much pointing. In order to keep the stonecutters always at work each man always had two stones bankered all the time, so that while the bull pointers were at work on one stone the stonecutter could work on the other. This was found to be advantageous. During the fiscal year 2,119.53 cubic yards of pointed face, special stones, and hollow quoins were cut, at a cost of $9.37 per cubic yard, of which $6.66 were for stonecutters' wages and $2.71 for bull pointing, piling, etc.

During the winter and spring the rough stone intended for backing was scabbled so as to have good beds; 5,412 cubic yards were scabbled, at a cost of 90 cents per cubic yard.

During the winter 30 line hooks, made of 2¼-inch round machinery steel, were fabricated for the masonry of the lock, and in addition 30 line hooks were fabricated for each of Locks Nos, 5, 6, and 7. Irons for snag boat to be built on the Obion River were also fabricated, cost of above work being kept separate and paid for from the proper appropriations.

The water supply has not been altogether satisfactory, and the sickness which has existed more or less among the working force is thought to be in a large measure attributable to this fact. During the past summer and fall the water supply was obtained by pumping from the river and filtering the water through 4 feet of sand and gravel. The water was so warm that ice was necessary to make it palatable. The cistern dug for storing water leaked so badly that it could not be relied on. During the past winter the sides and bottom of the cistern were plastered and concreted and a new roof put over it, at a total cost of $249.25. It was filled in February with water pumped from the river, and the water is now cool and sparkling, with a probability of remaining palatable all this season.

At the junction of the cofferdam with the bank on the upper end quite a wash and caving developed in 1897, and in order to prevent any further damage the bank was sloped and riprapped; 1,750 cubic yards of material were moved in sloping the bank, at a cost of 16 cents per cubic yard, and 322 cubic yards of riprap placed on the bank, at a cost of 71 cents per cubic yard. Preparations were begun for work of building the abutment by building bin for sand and gravel and moving engine and boiler across the river.

II. Above Nashville (at Lock No. 5, 72 miles above Nashville).—Operations carried on by hired labor have been in progress during the whole of the fiscal year. During the early summer the force was employed in repairing, calking, and painting boats and barges and making preparations for the regular season's work. The work for the fiscal year was setting pumping machinery, pumping out lock pit, finishing concrete foundation of lock, building brickwork of filling culverts, quarrying, tramming, cutting and piling stone for masonry, laying stone masonry in lock walls, and other incidental work.

The lock pit was pumped out September 12, 1897, using two 8-inch centrifugal pumps. After pumping out the first work was to stop the leak into the lock pit, as the large quantity of water entering from this leak taxed the pumps to their full capacity and required the consumption of large quantities of fuel. No attempt was made to shut off this leak entirely, but merely to reduce it to such an extent as to render the control of the water in the pit an easy matter. The leak was along the bottom under the cofferdam for a distance of about 80 feet from lower end. No definite point of entrance could be determined. Experience had shown in 1896 that by dumping material over an area of 15 feet by 50 feet alongside the cofferdam the leak was very materially reduced. Gravel was dredged on opposite bank of the river, loaded on barges by a dipper dredge, transported to the cofferdam, then dumped in place from scale board handled by the derrick boat. The expenditure of $251 in stopping the leak reduced the quantity of water so as to be controlled with ease by one pump. The method adopted was very efficient and an easy way to control the leakage.

An incline tram track was laid from top of the bank to side of lock pit, where a derrick was erected which could reach to the lock chamber. After the pit was pumped out the mud deposited by the high water was scraped up in piles, and while this was drying a tram track was laid from lower to upper end of lock. When the mud had dried out enough to be easily handled it was hoisted out with the derrick and dumped on the bank from the tram track; 525 cubic yards of mud removed, at a cost of 70 cents per cubic yard.

The leakage made it obligatory to concrete the foundation of the lock chamber. The leak extended in crevices under the cofferdam. These crevices were cleaned out

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as deep as could be reached with long-handled shovels, and, beginning on the inside of the crevices, the water was gradually forced back with concrete to the outside of foundation of lock wall. Here the water was carried through a trough around the outside of the lower end of the river wall to the pump sump. This trough was covered with about 2 feet of concrete. A drain trough 6 inches by 24 inches was placed in center of pit and 3 feet below top of concrete, so as to conduct all the leakage under the concrete to a sump below the lower miter sill. This drain is put in to comply with recommendation of the Board of Engineer Officers dated August 26, 1896. In the upper portion of the lock foundation no crevices were shown up and the concrete was put in 18 inches thick. There remains about 50 cubic yards of concrete to go in it, but it will not be laid until the masonry of the lock is completed, as it would necessitate the resetting of the pumps. The concrete is composed of Portland cement, 4½ cubic feet; sand, 11½ cubic feet; gravel, 12 cubic feet; broken stone, 13 cubic feet, the cement being one-ninth of the aggregate. This made, when thoroughly mixed and rammed, ninety-five one-hundredths cubic yard. Empire Portland cement, manufactured at Warners, N. Y., was used. The concrete was mixed and the stone broken by hand. Six hundred and thirty-nine and four-tenths cubic yards of concrete were laid, at a cost of $6.70 per cubic yard.

On account of the limited number of vitrified bricks available, some changes were made in the details of the filling culverts. The face of the culverts in the lock chamber are of cut stone and the bench walls of the arches are built in offsets on the back, so as to bond the brickwork to the stone masonry. The bond of the brickwork is further strengthened by means of hoop-iron bond, ordinary cotton ties being the hoop iron used. The brick were all laid in Portland cement mortar; 75,150 bricks were laid, at a cost of $6.72 per 1,000 for labor. Laying vitrified brick in cement mortar is slow work, the brick floating in the mortar, as it were. The work must be done with great care and slowly. Began laying brick October 14 and completed it November 9.

Began to lay masonry on October 19 and continued it until November 24, when all available stone was used up. A derrick was erected at the head of the lock to set the face of the culverts, the backing around the culverts, and build the upper end of the lock. Stone was delivered into the lock chamber and carried to this derrick on tram cars. A second derrick, erected at the lower end of the pit, set the lock walls as high as practicable with stone on hand, and then this derrick was moved ahead and the laying of masonry continued. While this derrick was being moved the gang of masons (3) were employed with the derrick at the head of the lock. A 12-inch course of pointed-face stone was laid from the recess quoin to upper miter sill on both the land wall and the river wall; a 2-foot 2-inch course of pointed face was laid from recess quoins to lower end of lock, leaving spaces for miter-sill hollow quoins. The walls were backed up as high as possible, leaving room for face stone and for stepping the work laid so as to permit a good bond when the work is resumed. All the joints in the backing were built up full with Portland cement mortar and spalls and left in such shape as to be easily cleaned when the work is resumed. Two thousand and ninety-four cubic yards of masonry were laid, at a cost of 88 cents per cubic yard for labor and $1.64 per cubic yard for labor and mortar. The expense of placing and operating pumping machinery, grading and laying tram tracks, erecting derricks and placing hoisting engines, and taking down and storing machinery and derricks at end of season amounted to $1,732.94, of which amount $642.48 was for material (fuel, oil, packing, etc.).

The quarry.—The most suitable quarry from which to obtain stone for the construction of Lock No. 5 was the subject of much thought. Past experience with quarries on the Cumberland River indicated that there would be much stripping and a large amount of waste stone not suited for masonry at any locality which might be chosen. For the lock, abutment, dam, and bank protection there would be required a total of about 25,000 cubic yards. Much of the dam, filling stone, paving, and riprap would be obtained largely from the waste stone. The stone would have to be towed if taken from any locality away from the lock, and this would have to be done during boating stages in the river, which is not the best time for quarry work. To have the quarry so located that stone when quarried and cut would have to be stored at the quarry demanded a large increase in the plant, which it was thought best not to make. A location within low-water boating limits was therefore deemed the most advantageous, and such a location was found on the left bank of the river within a short distance of the lock. The temporary quarters at the lock, with slight additions, could accommodate the working force.

The site chosen was on the return slope of the bluff on Rankin's farm. The face of the quarry is about 1,000 feet from the river and the floor of the quarry is about 122 feet above low water. In September the quarry was located, site cleaned off, machinery erected, and stripping and quarrying begun. In opening the quarry ample provision was made for disposing of all stripping and waste stone, and this has made it possible to keep the quarry cleaned up and in good working condition.

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The floor of the quarry being about 70 feet above the top of the river bank, some satisfactory means for lowering the stone had to be adopted. After discussing various plans it was decided that a gravity incline plane, similar to the one at Lock A, would be the best plan to adopt.

Drawing submitted herewith shows plan and profile of the inclined plane and the tram track. The end of the tram track at the river is on a trestle, with double track on the trestle. A stiff-leg derrick, placed on a crib whose top is 25 feet above low water, transfers the stone from the cars to the barges in the river. The quantity of stone taken is accurately determined by barge displacement. The barges are taken across the river and the stone is taken from the barges by means of a stiff-leg derrick, which can place it on cars on trestle to go to top of bank or on tram track to go into the lock pit. The stone which has so far been sent to the lock site is stone to be cut into pointed face and special stone. The stone intended for backing is piled under a derrick at foot of the gravity incline plane and a derrick near the end of the tram track close to the river bank. The tram track, gravity incline plane, trestle, crib, and pier derrick cost $1,939.15, of which amount $912.76 was for material.

Nineteen thousand one hundred and seventy cubic yards of material have been taken from the quarry, at a total cost of $16,814.26, of which amount $1,220.94 was for steel, fuel, explosives, oil, etc. From this material has been obtained 6,888.24 cubic yards of stone suitable for masonry, at a cost of $2.35 per cubic yard, about one-third of the material removed being stone suitable for masonry. There has been rather more waste stone than was anticipated, owing to the fact that the horizontal seams which were open on the exposed face of the quarry continue open as we go into the quarry. The stone quarried has good beds, and there will be but little work to prepare the backing and cut the squared faced rubble.

Three thousand two hundred and fifty-six and twenty-four one-hundredths cubic yards have been transferred to the lock site to be cut, and 3,632 cubic yards have been piled at the two derricks on tram track near the quarry. To transport and store the stone cost 23 cents per cubic yard. The stonecutters work under two stiff-leg derricks near the traveler on the lock site. The track from the trestle to the traveler runs through the stone yard. The stone is hard on tools. The same method of management in the stone yard is pursued here as was followed at Lock A. One thousand seven hundred and eighty-nine and twenty-one one-hundredths cubic yards of stone has been cut, at total cost of $12,036.39, of which $402.98 is for material (coal, steel, etc.). The cost per cubic yard for cutting and piling the stone was $6.72, of which $4.50 was for stonecutters' wages. The good beds on the stone made the cutting more economical than that done at Lock A.

The plant in use at Lock No. 5 was bought for Lock No. 4 and Lock No. 5. The following plant was bought for Lock No. 4 and used there until masonry of lock was completed and then brought to Lock No. 5: 6 steam boilers, 6 tram cars, 2 steam drills, 9 derricks, 2 stationary engines, 11 American Hoist and Derrick Company's 6½-inch by 10-inch double-cylinder, double-drum hoisting engines, 2 centrifugal pumps, 4 duplex pumps, and 10,840 linear feet of rail for tram track. The following was bought for Lock No. 5: 3 centrifugal pumps, 12 tram cars, irons for derricks, 2 stationary engines, 1 boiler, 2 duplex pumps, 1 drum for gravity incline plane. The plant has been kept in good condition. The derricks will require new timbers, and some work is necessary on the trestle to the traveler.

All the floating property belonging to the Cumberland River has been kept at Lock No. 5 except when in use elsewhere. The list is now:

U. S. steamers *Cumberland, Susette, John Phœnix*; 6 barges 110 by 22 by 5 feet; 2 barges 60 by 14 by 2.5 feet; 1 barge 80 by 24 by 3.6 feet, fitted up for use as snag boat; 1 dredge boat; 1 derrick boat; 1 flatboat used for ferrying at Lock 5; 1 flatboat or batteau, 30 feet long, for general use at Lock A; 2 skiffs.

The barges were all turned over, calked, and painted; the snag boat overhauled and painted. The derrick boat had some minor repairs. No repairs made to the dredge boat, which should have a new boiler before it is operated much more. The steamer *Susette* was painted and had her wheel repaired to such an extent as to make it practically a new wheel. The *John Phœnix* was calked, most of main deck renewed, new fire bed to boiler, new canvas roof put on, new chimney, shaft and flanges repaired, new wheel put on, boat painted, main boiler feed pump installed, and new throttle valve put in place. The boat and machinery have been gone over carefully and everything put in good order. The woodwork of the *Weitzel* having become so much decayed as to be unsafe without repairs greater than was advisable, a new hull and cabin have been built by Capt. E. J. Howard, Jeffersonville, Ind., the machinery overhauled, California cut-off put in the engine, and electric-light plant, including donkey boiler, installed. It is a well-built boat, was accepted June 25, and has been renamed the *Cumberland*. The old hull of the *Weitzel* was sold at public auction for $725. The *Susette* has been in commission seven months during the fiscal year and was employed in towing heavy material to Locks 5 and A and

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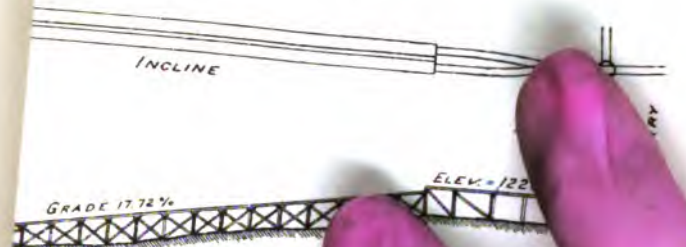
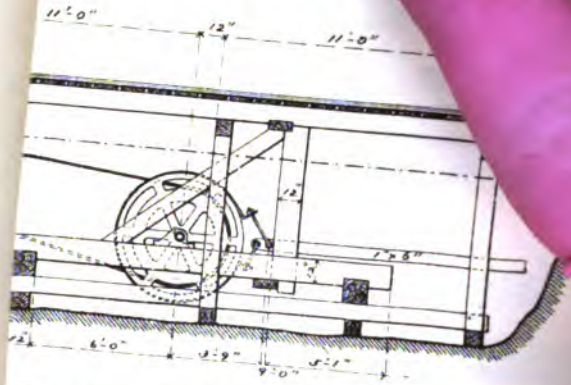


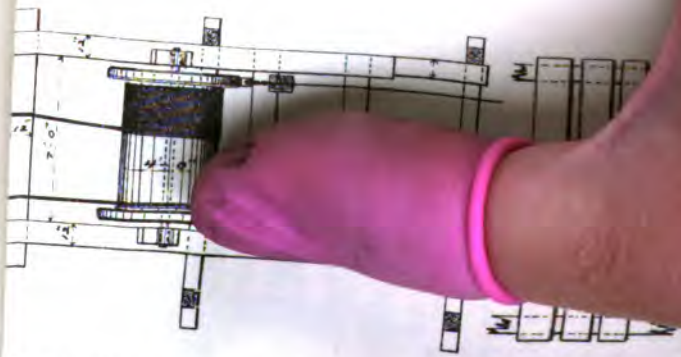
PROFILE OF TRAMWAY

SCALE 80FT. = 1 IN.



ELEVATION OF GRAVITY DRUM

SCALE ⅜ IN. = 1 FT.



PLAN OF GRAVITY DRUM

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in transferring barges across the river at Lock No. 5. Four hundred and forty-seven and nine-tenths cubic yards sand, at 60 cents per cubic yard, and 481.1 cubic yards gravel, at 50 cents per cubic yard, purchased and delivered in month of June for masonry of lock to be constructed. Timber to renew derricks and build new derricks and repairs of travelers received at Lock No. 5 during June, 1898.

Lock No. 6 (89.6 miles above Nashville).—Contract was entered into May 4, 1897, with McArthur Bros. Co. for constructing this lock and abutment. Work was begun in July, 1897. During the year the contractor erected the necessary temporary buildings for his working force; built the cofferdam and pumped it out; began and continued excavation of rock for lock foundation until driven out by high water December 21, 1897. The excavation for lower approach in progress at this date was suspended for same reason; erected wire fence around Government sites; built tram track from quarry to lock site; opened quarry, quarried stone, cut stone, and transported stone to site.

In September, 1897, work was begun opening quarry on the river bank about half a mile from the lock site and a small force was engaged until the 1st of January, 1898. Since this date the quarry force has been steadily increased, and now there is an average of about 120 men employed. The quarry has a face of about 250 feet long and 30 feet in height. Five new derricks are used for quarrying, all having steam-hoisting engines. Two portable boilers supply steam to steam drills and pumps. One Sullivan channeler was used for a short time. Nine quarry foremen are employed, with gangs varying in number from 10 to 30 men. The output of the quarry is about 60 cubic yards per day. The cutting is done under three derricks near the quarry, and 50 stonecutters are employed under one foreman. Only recently the force of stonecutters was increased to its present number. During the earlier part of the year only about one-half as many were employed. Bull pointers, derrick hands, and laborers to the number of 55 are engaged in the cutting yards. The stone is delivered at lock site on cars drawn by horses over a 3-foot gauge tram track about 3,400 feet long. Four horses are used in this service. Stone is delivered as soon as dressed. Three derricks in the piling yard on the hillside near the lower end of the lock handle and pile the dressed stone. On June 30 the pile contained, of all classes, 3,983.3 cubic yards, as follows: Special stones, 64.8 cubic yards; pointed face, 733.4 cubic yards; squared faced rubble, 976.7 cubic yards; backing, 2,208.4 cubic yards. From Lock 6 there was sent to Lock 7 2,300 cubic yards dressed backing and 1,800 cubic yards of rough stone.

Two houses for storing cement have been built on the hillside near lower end of the lock. They are well adapted to the purpose, and have a floor space of 6,500 square feet. Two thousand barrels of Portland cement and 1,820 barrels of Louisville cement were stored in these houses on June 30, so as to be on hand when laying of masonry is begun.

A wire fence inclosing the United States lands was built by the contractor. At end of the fiscal year active preparations were in progress for resuming work of excavation in the lock pit and the commencement of work on the abutment.

Lock No. 7 (106.6 miles above Nashville).—Contract for constructing this lock and abutment was made with McArthur Bros. Co., of Chicago, Ill., May 4, 1897. Work was begun in July, 1897. During the year the contractor erected the necessary temporary buildings for his working force, placed wire fence around United States lands, assembled the necessary plant, built the cofferdam, prospected for quarry, opened quarry at Rome, Tenn., quarried, cut, and transported stone, erected derricks and tracks for storing stone at lock site, and piled all the stone brought from the Rome quarry and from Lock 6. The cofferdam was finished in November, 1897, and all tools and working force moved to the Rome quarry November 19, 1897, since which date active work has been in progress at the Rome quarry.

The contractor decided that the most advantageous site for the quarry from which to obtain stone for this lock was at Rome, 4.2 miles below the lock. The quarry is located on the return slope of the bluff, just below the town, and, taking everything into consideration, it is about the best quarry on the Cumberland River. The face of the quarry is about 750 feet long and from 17 feet to 32 feet high, is worked by 8 derricks, 8 foremen, and about 100 men. The cutting is done under 3 derricks, and about 65 stonecutters are employed and about 65 bull pointers, derrick hands, and laborers. The dressed stone is let down off the bluff on a gravity incline plane within reach of the loading derrick, which transfers the stone to the barges, on which it is towed to the lock site. The plant in use at the Rome quarry consists of 13 derricks, 12 of which have steam hoisting engines, 5 of which have bull wheels and steam swinging gear (1 derrick is served by horse power), 10 steam drills, 1 baby steam drill, 2 quarry bars, 5 tram cars for stone, 2 dump cars for stone, 4 dump cars, 1-foot 6-inch gauge for stripping, 900 feet tram track having 3-foot gauge, 960 feet tram track for stripping, 1 gravity incline plane, double track, 183 feet long, operated by a double drum (4 feet diameter) and cable. During the boating season 3 steamboats were employed on the water, 2 the property of the contractor and 1 chartered. Nine

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barges were in use for transportation of stone, coal, cement, etc. At the lock site ample provision is made for receiving and storing the dressed stone. There is a derrick erected on a pier both above and below the lock. Trestles are built out from top of bank, on which are tram tracks which can be reached by these derricks, which take stone from the barges and deposit it on tram cars to be taken to the piling derricks, where it is stored. For storing the stone 3 traveling derricks are used, 1 for pointed face, 1 for squared faced rubble, and 1 for backing. On June 30 there had been delivered and piled on the lock site 9,964.55 cubic yards of stone of all classes, as follows: Sills, 28.97 cubic yards; hollow quoins, 15.26 cubic yards; special stones, 468 cubic yards; pointed face, 1,414.81 cubic yards; squared faced rubble, 1,019.37 cubic yards; backing, 7,018.14 cubic yards.

A house for storing cement, 350 feet long by 22 feet wide, has been erected, and in it are stored 1,900 barrels of Portland cement and 1,200 barrels of Louisville cement in readiness to be used for the masonry of the lock and abutment. The plant in use at the lock is very complete, consisting of 3 traveling derricks, 2 pier derricks, 2 derricks for storing, paving, and for cutting backing. Six of these derricks are provided with bull wheels and double-cylinder, double-drum hoisting engines with swinging gear. The seventh derrick has no bull wheel and no swinging gear on its hoisting engine. There are 415 feet of 3-foot 2-inch gauge 60-pound rails for the traveling derricks; 900 feet tram track, 3-foot gauge; 500 feet tram track, 18-inch gauge; 8 cars, 3-foot gauge; 2 cars, 18-inch gauge; one 12-inch by 20-inch stationary engine; two 40-horsepower locomotive boilers; one 12-inch centrifugal pump, and all the necessary small tools. The foundation for the abutment was staked off in June, and work of excavation was in progress at end of the fiscal year.

Mr. S. H. Ellison has been the overseer at Lock A during the fiscal year, assisted by Mr. John Irwin, master quarryman, and Mr. George B. Oakshott, master stonecutter. Mr. W. M. Nance has been the overseer at Lock No. 5, assisted by Mr. John Irwin, master quarryman, Mr. Thomas Gallagher, master stonecutter, and Mr. John S. Butler, receiver of materials. Mr. B. F. Cheatham, chief inspector at Lock No. 6, assisted by Mr. J. I. Miller, inspector. Mr. A. D. Edwards, chief inspector at Lock No. 7, assisted by Mr. George B. Oakshott and Mr. Charles E. Bright, draftsman in Nashville office, now inspector at Lock 6 in place of Mr. Cheatham, who is a major of the First Regiment of Tennessee Infantry, United States Volunteers. All the above-named employees have discharged their duties with commendable zeal and intelligence.

Very respectfully, your obedient servant,

J. S. WALKER, *Assistant Engineer.*

Maj. DAN C. KINGMAN,
Corps of Engineers.

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APPENDIX D D.

IMPROVEMENT OF TENNESSEE RIVER AND ITS TRIBUTARIES.

REPORT OF MAJ. DAN C. KINGMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River.
2. Operating and care of Muscle Shoals Canal, Tennessee River.
3. French Broad and Little Pigeon rivers, Tennessee.
4. Clinch River, Tennessee.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., July 9, 1898.

GENERAL: I have the honor to transmit herewith my annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1898.

Very respectfully, your obdient servant,

DAN C. KINGMAN,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

THE DISTRICT.

This district was in charge of Maj. Dan C. Kingman, Corps of Engineers, during the entire year. The division engineer was Col. Henry M. Robert, Corps of Engineers.

TENNESSEE RIVER SYSTEM.

The nature and extent of the Tennessee River drainage basin, general character of the river, and the number and length of its navigable tributaries was fully described in the Report of the Chief of Engineers for 1897, page 2247. There was also given in the same report a description of the nature and extent of the commerce upon the river, the character of the obstructions to navigation that are encountered, and the methods which have been adopted to overcome or remove them.

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D D 1.

IMPROVEMENT OF TENNESSEE RIVER.

[Length, 640 miles.]

The junction of the Holston and French Broad rivers, 4½ miles above Knoxville, is now generally taken as the head of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the fifty-three or more tributaries of the Mississippi River, the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigable from its source to its mouth, a distance of 640 miles, during several months of the year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river so as to make navigation continuous throughout its entire length for boats of moderate draft, is by no means an impossibility.

Now that the great obstruction of the Muscle Shoals has been overcome by the completed canal, and Colbert Shoals is in process of being done away with in the same manner, it is more annoying to the now really brightening prospects for river navigation to have to contend with the smaller obstructions which exist in a number of places along the river. These obstructions are very short in length, but no whit less obstructive than the longer ones.

1. ABOVE CHATTANOOGA (188 MILES).

This section of the river is navigable except during the periods of very low water, which occur during the summer and fall months. At such times navigation can only be carried on with very small and light-draft boats, excepting during the occurence of the so-called "rain tides."

The commerce of this portion of the river is carried on by means of steamboats carrying freight and passengers, and generally towing one or more barges; by flatboats descending with the current from the upper tributaries, and by rafts of lumber and logs. The latter constitute an important part of the commerce of the upper Tennessee River.

In 1830, Col. S. H. Long, United States Topographical Engineers, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as House Ex. Doc. No. 167, Forty-Third Congress, second session, gives a detailed description of every obstruction to navigation at that time, and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of the Chief of Engineers, 1871, pp. 502–507, and 1872, pp. 488–494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water, and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any

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improvements more or less permanent, with the exception of the removal from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams; but there is no record of the work done, and it did not prove of lasting value.

In 1871 an examination was made, and upon it a project of improvement based, which provided for the removal of snags and drift and for deepening the channel at the worst obstructions by blasting and dredging or by scouring the bars by the aid of wing dams, to an extent that will secure a channel 3 feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891, for the reasons stated in the reports of those years.

Under the provisions of the river and harbor act of September 19, 1890, a "careful and comprehensive survey" of the Tennessee River above Chattanooga was made "with a view of ascertaining to what extent the navigation of the river is capable of improvement, and the cost of the same and the preparation of suitable plans therefor." This survey was begun in May, 1891, and completed during the fiscal year 1893. The report, with estimate and plans, was submitted to the Secretary of War in February, 1893, and forms House Ex. Doc. No. 252, Fifty-second Congress, second session. The plan of improvement proposed was the same as that formerly in progress, as above stated; that is, to obtain a 3-foot low-water navigable channel between Chattanooga and the mouth of the French Broad River, at an additional estimated cost of $650,000. The project based on the survey of 1891 received Congressional approval in the river and harbor bill of August 18, 1894.

Eighteen appropriations have been made by Congress for this work, aggregating the sum of $361,000, viz:

Act of—		Act of—	
April 10, 1869	$35,000	August 2, 1882	$7,000
June 10, 1872	25,000	July 5, 1884	3,000
March 3, 1873	25,000	August 5, 1886	7,500
June 23, 1874	25,000	August 11, 1888	15,000
March 3, 1875	40,000	September 19, 1890	30,000
August 14, 1876	15,000	July 13, 1892	25,000
June 18, 1878	15,000	August 18, 1894	50,000
March 3, 1879	11,500	June 3, 1896	15,000
June 14, 1880	10,000		
March 3, 1881	7,000	Total	361,000

The total amount expended, including outstanding liabilities, to June 30, 1897, was $341,059.25.

This expenditure has resulted in giving a lengthened season of navigation and an improved channel at 29 of the 43 obstructions enumerated by Colonel Long in his report of the examination made in 1830. The work has also resulted in rendering the general navigation of this portion of the river safer and easier, and has permitted a reduction in freight rates. The work has consisted in some cases of the removal of bowlders and the excavation of rock and gravel in the channel. This style of improvement, where not too expensive, is desirable and can as a rule be safely made. The size of the channel which it is necessary to excavate bears such a small proportion to the entire area of cross section of the river that no injurious lowering of the upper pool results. By far the greater part of the work done, however, has consisted in the construction of wing dams and retaining walls, designed to elevate the surface of the water on the shoals, to equalize its slope and consequent

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velocity. Work of this kind has been remarkably permanent. Very little that has ever been built has been destroyed. The improvement, however, resulting from this work has not always been equally permanent. As elsewhere described, the tendency of such work is to form a bar at the lower end of the chute and to transfer the difficulties downstream. The work built, however, is generally valuable, and by proper extensions and the construction of spurs to assist the low-water current in cutting through the bars, can be made valuable for a permanent improvement. The improvements made at White Creek Shoals and Soddy Shoals were judiciously planned and have stood the test of several years' trial, and appear to be permanent and satisfactory.

The principal work of channel improvement during the past season has been done in the immediate vicinity of Knoxville, Tenn., in accordance with the approved project. One of the principal obstructions to navigation at this place consisted of 12 crib piers standing in the river, their tops being at about the level of ordinary low water. They were the remains of a military bridge which was constructed during the civil war by the United States troops under the command of General Burnside. The superstructure of the bridge long since disappeared, but the parts below water were still standing. They consisted of timber cribs filled with stone. They were removed by dredging and the use of derrick boats, and the stone filling was used in strengthening the dams in the vicinity of the county bridge.

The channel of the river from the county bridge down to the Marysville Railroad Bridge, a distance of about a mile, was cleared of loose rock and stone, and a training wall was constructed below the Marysville Bridge to raise the water surface and equalize the slope, and, consequently, to reduce the maximum velocity of the current. This training wall extended from the foot of the island and was about 350 feet in length. Three spurs or check dams, each about 130 feet long, were built out from the training wall to increase its efficiency.

The entire work of improvement at this place could not be completed, owing to the fact that a new bridge was in process of construction across the river at the city of Knoxville. This bridge is being built by the county under authority of Congress and takes the place of a bridge already in existence. It has wider spans than the old bridge, and both sets of piers are now in the river. The law requires the county to completely remove the old bridge, but the time within which they are allowed to do this has not yet elapsed. In the meantime the channel is considerably obstructed, but not to such an extent as to prevent navigation. When these piers are removed it will be possible to complete the proposed improvement at this place.

At Caney Creek Shoals a gravel bar, which formed many years ago at the head of the shoals, and which could not be removed by the action of the current without too much contraction, was excavated by dredging. About 2,100 cubic yards of gravel were thus removed. The long training wall at the shoals was lengthened 214 feet, and a short spur was built at the lower end of it.

In addition to this, a party was sent from the junction of the French Broad and Holston rivers, 4 miles above Knoxville, down over the entire river to Chattanooga, a distance of 188 miles. This party cut down and destroyed overhanging trees which interfered with navigation and removed snags and some loose bowlders from the channel. Eight thousand five hundred and one leaning trees were cut down, some of them being of enormous size, thus clearing up a total of over 34,000 linear feet of bank, and 1,018 snags were removed from the

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channel. This work will greatly increase the safety and ease of navigation of this portion of the river. Indeed, there is nothing that can be done upon a river of this character for a small expenditure, that affords so much gratification to those using it, as the removal of snags and the cutting of overhanging trees.

For the details of the foregoing work I would respectfully invite attention to the report of Supt. R. R. Thacher, which is transmitted herewith.

Money statement.

July 1, 1897, balance unexpended	$21,911.31
June 30, 1898, amount expended during fiscal year	15,004.04
July 1, 1898, balance unexpended	6,907.27
July 1, 1898, outstanding liabilities	438.37
July 1, 1898, balance available	6,468.90
Amount (estimated) required for completion of existing project	585,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	65,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

2. CHATTANOOGA, TENN., TO DECATUR, ALA. (145 MILES).

The most serious obstructions to navigation found upon this section of the river are situated in the mountain region immediately below Chattanooga. For about 25 miles the river is rigidly confined by the mountains; its channel is crooked and exceedingly narrow. The fall is very rapid, and the strong current which results is a most serious obstruction to navigation. In 8½ miles of this distance there is a fall of 16½ feet. Considerable work has been done in widening the cross section of the low-water channel by the removal of bowlders, projecting rocky points, and overhanging trees. This has resulted in somewhat diminishing the velocity of the current and equalizing the fall, but the upstream navigation is still attended with delays, caused by the necessity of laying lines and warping vessels over the swiftest places. It is impossible to diminish the slope by a development of the channel, and the limit of improvement by channel work is very soon reached. When the great obstructions at Colbert Shoals and Big and Little Muscle shoals have been completely overcome by canals, the greatest difficulties and dangers to navigation on the river will then be encountered in this mountain section. Bars and reefs and shoal water elsewhere cease to be obstacles when the river attains a sufficiently high stage, but in the mountains the current increases with the rise of the river, and there is no stage at which navigation is good.

This stretch of river could undoubtedly be improved by the construction of one or more dams with locks, thus dividing it into pools. The locks of course could not be operated at extreme high water; at a certain determined stage it would be necessary to permit the dams to be drowned out, the locks submerged, and to require navigation to follow the open river. This method of improvement has received some consideration in the past, but the very considerable cost of the improvement has told against it.

After the river passes the mountains its character changes, and from thence down to Decatur the river is generally wide and shallow, with a gentle slope. The obstructions are broad, flat bars, sometimes composed of solid rock, but more often of hardpan, in which large bowlders are embedded; at other places the obstructions are rock reefs. The

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veins of blue flint, which were embedded in the rock which forms the bottom of the channel, have been exposed by the erosion of the softer rock adjacent until they stick up a foot or more above the general level of the bottom. They are usually inclined, but sometimes nearly vertical. They can be blasted off and a limited improvement thus obtained.

The United States dredging plant, consisting of the stern-wheel towboat *McPherson*, the *Harwood* (an Osgood dipper dredge), a 12-horsepower steam derrick boat, a quarter boat, and four barges, was employed during the season upon that portion of the river known as the mountain section, and which lies immediately below the city of Chattanooga.

Immediately below Chattanooga the Tennessee River breaks through the range of mountains which heretofore have bordered it upon the right bank. For about 20 miles, measured along its channel, it pursues a very crooked course through this rugged country. Its bottom and banks are generally of rock, and its channel is greatly confined by the mountains. The fall is great and at many points excessive, and the velocity of the current affords the most serious obstruction to navigation.

At the place known as the "Skillet" the low-water channel is narrowed by a gravel bar upon the right bank and a salient point upon the left; the fall at this place in low water amounts to 3 feet in 300, and most of this fall is concentrated opposite the point on the left bank. At low stages it was impossible for boats to pass this point without the aid of lines secured to the bank and powerful capstans to assist the action of the wheel. Delays of one or two days sometimes were caused at this place. A large amount of dredging has been done during the past year at the left-hand point. Three cuts were made and over 6,000 cubic yards of material was removed. This material consisted of loose stone and large bowlders, the interstices being filled with gravel and sand. Great difficulty was encountered in holding the dredging plant in place so that it could work, the velocity of the current being about 9 miles an hour. The work resulted in increasing the width of the channel about 75 feet and greatly diminishing the maximum velocity of the current. Boats are now able to pass this place with much greater ease than formerly.

All of the difficulties of navigation in this section of the river are not encountered during low water. Owing to the steepness of the banks the cross section of the river does not rapidly increase as the river rises, and it is therefore gorged at a number of places, so that the high-water current is very excessive. Steamboats ascending the river are obliged to keep close to the banks in order to escape the maximum force of the current.

At two places, known as the "Pot" and the "Pan," the high-water current is very great and the banks were greatly obstructed by trees and large bowlders. At the "Pot," upon the left bank, about 2 acres of ground were cleared and nearly 600 cubic yards of large bowlders were broken up by drilling and blasting, and the fragments so disposed as to leave the surface of the bank quite smooth. At the "Pan," on the left bank, 4 acres were cleared in a similar manner, about 240 cubic yards of bowlders being disposed of.

About 5 miles below Chattanooga the river is divided by a long island known as Williams Island. The channel in use has been down through the right-hand chute, but this is obstructed by a shoal known as Burris Bar, which renders the water very shallow, less than 3 feet at extreme low water, for a distance of several miles. For that reason work has been done with a view to improving the left-hand chute, which has a general depth at low water of not less than 6 feet, the

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obstructions being concentrated at the head of the chute and at a point about halfway through it.

The obstruction at the head of the chute known as the Blue Suck consisted of a gravel bar and a series of rock reefs about 18 inches thick, extending upward from the bottom of the river at an angle of about 40 degrees to the horizontal.

About 6,000 cubic yards of material was dredged from this place, but the work could not be completed because the dredge was needed elsewhere, though the channel as it now is can be used.

At Jackson Bar, about halfway down the island, there are several rock reefs similar to those at Blue Suck. A space about 100 feet by 300 feet was drilled and blasted, and when the débris is removed it will afford a sufficient channel. This will be done when funds are available.

At Lookout Shoals some work was done in removing loose rock from the channel, thus securing an increased depth of about half a foot.

Between Hobbs Island and Guntersville, a distance of about 21 miles, is a stretch of river which is passed over several times a day by the steamboats belonging to a railroad transfer company. A good deal of work has been done upon this section by the United States, and useful navigation is now possible at stages when formerly the river could not be used. A few bowlders were discovered during the past season of extreme low water which interfered with navigation, and at the request of the manager of the company a small party was sent to remove them. The result has been reported to be very beneficial.

The most important work done during the season was at Ross Towhead. This is the first shoal encountered in descending the river from Chattanooga. Extensive work was carried on at this shoal under a contract beginning in the fall of 1891, but funds were exhausted before the improvement was completed. Last year it was found that at some places in the channel there was only 1.1 feet of water, even when the river lacked three-tenths of being at its lowest stage. It was thought that the blasting already done by the contractor would permit this material to be removed with the dredge. A trial, however, proved that this was not the case; most of the rock was found to be quite solid. Accordingly, an area 110 feet wide and 1,100 feet long had to be drilled over and blasted and the débris removed with the dredge; 3,000 linear feet of holes were drilled, and 6,757 cubic yards of rock and 1,764 cubic yards of gravel were removed, at an average cost of 61.3 cents per cubic yard. Considering that the rock was a blue flint of exceeding hardness, this is a most extraordinarily good record. The contract price for this work was $1 a cubic yard for gravel and $3.75 a cubic yard for rock. This work gives a depth of 3 feet in the channel at extreme low water, with the exception of a few points where loose stone, which the dredge failed to take up, slightly reduce it. The lateness of the season at which the work was closed prevented these stones from being removed with the derrick.

For the details of these several works, I would respectfully invite attention to the report of Asst. Engineer W. S. Winn, who was in local charge at that time.

3. DECATUR, ALA., TO FLORENCE, ALA. (50 MILES).

The principal obstructions upon this section of the river are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence (38 miles) and embracing Elk River Shoals, Big Muscle Shoals, and Little Muscle Shoals. Only 8 miles of this distance of 38 miles is navigable in its natural condition.

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The Elk River Canal, a mile and a half long, having two locks with lifts of 12 feet, and from 8 to 11 feet, respectively, overcomes the obstruction at Elk River Shoals.

The Big Muscle Shoals Canal, originally built for the United States by the State of Alabama, which was completed in 1836 and practically abandoned in 1837, overcame the obstruction of the Big Muscle Shoals. This canal was subsequently repaired by the United States, its locks remodeled, enlarged, and given increased lifts whereby their number was diminished, and the whole completed in 1890.

An attempt was made to overcome the difficulties of navigation on Little Muscle Shoals by channel work, but the fall is too great and the limit of the improvement was reached without satisfactory results. The project has since provided for the construction of a canal 15,000 feet long, with a guard lock at the head and a lift lock at the foot, having a lift of 12 feet, to overcome this obstruction.

The Big Muscle Shoals and the Elk River Shoals divisions of the canal permit navigation through them at all stages of the water. Between these two canals there is a stretch of water about 8 miles long which still offers a number of obstructions to navigation. A good deal of work has been done here, but in their present condition these obstructions are sufficient to stop navigation between the two divisions of the canal even before extreme low water is reached.

No work of improvement was undertaken upon this portion of the river during the past year, owing to the lack of funds. A certain amount of repair work was done, however, to the dam above the Elk River Shoals. This was work necessary to the maintenance of the canal, and was done with funds obtained from the allotment for operating and care.

4. FLORENCE, ALA., TO FOOT OF BEE TREE SHOALS (30 MILES).

Bee Tree and Colbert shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during low water.

These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, at which stage the available depth is about 1.5 feet.

Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The total amount actually expended on the improvement of these shoals from the beginning of improvement in 1827 to June 30, 1890, including surveys, excavation of rock from the channel, and construction of dams, was $62,243.41.

The project adopted in 1890 contemplates the construction of a lateral canal on the south bank of the river 7.8 miles long, 150 feet wide at the water surface, with a depth of 7 feet. A combined lock, with a total lift of 25 feet, was originally intended to be placed at the lower end and a guard lock at the head, for use when necessary at very high water, the locks to be 80 by 350 feet, with a depth of 6 feet on the miter sills at extreme low water.

This project was modified, after the detailed surveys of 1891 were completed, by substituting for the combined lock two locks of 12 and 13 feet lift, respectively, at extreme low water, separated by a pool 1 mile in length.

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This project was again modified in 1892 by the substitution of one lock of 25 feet lift for the two locks contemplated in the project as modified in 1891, retaining the guard lock at the head of the canal.

A contract for the construction of the lift lock at Riverton, Ala., was entered into August 10, 1893, with Tere A. Clark, of Quincy, Ill.

Operations under this contract were continued with ever-increasing difficulties and diminishing results until December 17, 1894, when the contractor ceased all active work, owing to a strike among his employees. The contract was annulled in January, 1895, and by February 1, 1895, the United States had assumed charge of the work. Comparatively little had been accomplished by the contractor, his efforts having been principally confined to excavation of lock pit.

Under the project $438,290.41 was expended up to the close of the fiscal year ending June 30, 1897, in making a survey for the location of the canal, the purchase of land necessary for the right of way, in making preliminary borings and excavations, in preparing suitable drawings and specifications, in the purchase of lock-gate anchorages, in acquiring and erecting the necessary plant, in opening the quarry at Cherokee, Ala., and in the construction of the masonry of the lock.

The Annual Reports of the Chief of Engineers for the fiscal years 1896 and 1897 give detailed descriptions of this lock with photographs and drawings for the purpose of illustration. The plans originally adopted have been carefully adhered to and the high standard proposed has been maintained throughout. The masonry of the lock which is now completed will bear critical inspection and comparison with any similar structure.

Owing to the small amount of money available for the continuance of the work, it was not possible to begin the construction of the guard lock or to undertake any work along the line of the canal. The only thing that could be undertaken was the completion of the entrance to the lift lock from the river. A Board of Engineer Officers having prepared a plan for the construction of this entrance about the close of the previous fiscal year, preparations were made to carry it into execution. The work of excavating the earth at the entrance was placed under contract with John B. Neely, of Chattanooga, Tenn. The contractor commenced work early in July, 1897, and the terms of his agreement required him to complete the excavation, with the exception of the embankment or levee across the entrance to the river, in sixty days; but owing to the difficulties which the contractor apparently had not foreseen and which he appeared to be unable to quickly surmount, it was necessary to grant him three extensions of time, so that the final completion of this portion of his work was not reached until early in December, instead of early in September, as was originally intended. This was so near the time at which a rise in the river might be anticipated that it was not thought practicable to complete the masonry before the coming high water.

To protect the earth slopes at the side of the cut until the masonry walls could be built, a force was put at work behind the contractor to take out a sufficient quantity of rock from the entrance to construct dry stone walls along each side. These walls were made about 15 feet high and 10 feet thick, and they served the purpose very well. No injurious slides have taken place. About 4,700 cubic yards of rough stone was used in these walls. They were set back of the line to be occupied by the regular retaining walls, and they will serve not only to furnish drainage back of the walls but they will greatly increase their stability.

A rise in the river in the latter part of December was sufficient to

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breach the protection levee and flood the lock. This was anticipated and no loss resulted.

While the entrance was being excavated provision was made to procure the necessary material for the walls. It was estimated that, in addition to the stone already on hand, about 8,000 cubic yards would be required. Of this, about 2,000 cubic yards could be purchased in the vicinity, 2,000 cubic yards more obtained from the excavation, and 4,000 must be obtained from other sources. Proposals were invited for furnishing this, but without success. Upon investigation it was discovered that a suitable ledge of limestone existed at Cherokee, Ala., a short distance below the point from whence the sandstone used in the lock was obtained. An arrangement was accordingly made to procure the desired quantity from this place. Some work of stripping and a little quarrying has already been done. About 350 cubic yards of stone have been delivered at the lock site from the quarry. By this time, however, the weather had become quite cold, and some of the green stone was so seriously affected by the action of the frost that quarrying was suspended, to be resumed as soon as the stone was actually required for construction.

The stone to be purchased in the vicinity consisted mainly of about 1,700 cubic yards, which had been gotten out and partially wrought by the failing contractor. This stone was still in the hands of the receiver. He was very glad to sell it to the United States, at the place where it was situated, at an average price of 80 cents a cubic yard. Derricks were arranged, and the stone was loaded upon barges and towed down over Colbert Shoals to Riverton by a boat belonging to the United States. Between the 20th of July and the 20th of August the U. S. towboat *Colbert* made 25 trips with stone, carrying in all 3,650 tons, or an average of 140 tons a trip. During this period the gauge at Riverton fell down to eight-tenths of a foot above zero, a stage very much lower than that at which the shoals were ever surmounted by ordinary boats for commercial purposes. Neither the towboat nor its barges were injured in passing over the shoals at this remarkably low stage.

Arrangements have also been made for the purchase of the necessary quantity of cement and sand for the construction of the masonry. A force of stonecutters was employed until cold weather and they have cut the greater part of the stone required for the work. As soon as the river attains its lowest stage, and the season is most favorable for work, operations will be resumed, and the masonry of the entrance will be rapidly completed.

The earth obtained from the excavation to the entrance, amounting to something over 60,000 cubic yards, was used to cover the spoil banks on the south side of the lock. It was graded and shaped so as to form a terraced mound, the surface of which is about 3 feet above the level of extreme high water. It affords a level area about 100 feet wide and 400 feet long, which can be used as a site for the lock-keeper's house and for such other buildings as it may be desirable to erect at this place. This embankment, constructed as it was of new earth, has been carefully tended and prevented from washing into gulleys. The slopes have been planted with Bermuda grass and oats, and a sod will soon form which will resist the action of water during the short time which it will be exposed to it in any extraordinary rise of the river.

The stone and other material now on hand for the completion of the entrace is estimated to be worth more than $22,000.

In addition to the work already described, much study and investigation has been given to the various details connected with the construction of the guard lock and the canal. The question of a power

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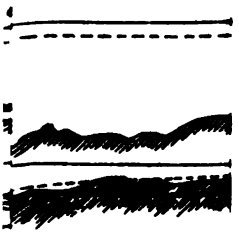

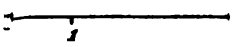

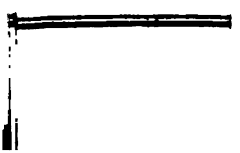

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house and operating machinery for the lift lock has been carefully considered, and plans have been carried far enough to determine upon the size and location of the openings to be left in the entrance walls for the tailrace from the wheels to be installed for furnishing the necessary power. The kind of engines and the power which they must develop to operate the gates under all conditions has been determined, and study has been made as to the best method of accumulating the necessary power.

The watershed and drainage of the area naturally tributary to the canal has been carefully studied, and plans have been prepared and submitted for taking care of the storm water, which in the natural course would find its way into and flood the canal. The proposed project provides that five of the creeks at the lower end of the canal shall be carried under it by means of culverts and that all the other creeks shall be allowed to empty into it. This will permit the drainage from 3,000 acres to flow into the canal and that from 6,500 acres to be carried under it.

A study has been made of the kind of gates most suitable for the guard lock, both as main gates and guard gates, and the straight mitering gate with vertical framing has been recommended and adopted. A general plan for the masonry of the upper lock to conform to these conditions has also been prepared and submitted.

The high water of March, 1897, which exceeded by 2 feet all previous known high waters in this vicinity, necessitated decided changes in the previous designs for the guard lock and for the levee or embankment between the canal and the river. The absolute strength and security of this embankment is necessary for the preservation of the canal. The plan requires the water of the river to be kept out of the head of the canal and only to get into it by backing up from the lower end. From the fact that the fall in the river at extreme flood is 3 feet in the length of the canal, a breach near the head of the canal would cause a 3-foot fall from the river. This would certainly cause the destruction of a large portion of the embankment and would fill with deposit a considerable portion of the canal.

The volume of the embankment has been carefully computed and compared with the proposed section of the canal, and it is found that the canal, as proposed, will by no means furnish the earth necessary for the embankment. It will therefore be necessary to obtain the additional earth either by increasing the cross section of the canal nearly 40 per cent or else by opening up borrow pits in the vicinity. It will also be necessary to purchase at least 125 acres of additional right of way to furnish sufficient base for the embankment.

A drawing, showing the location of this canal and locks with respect to the river, and based upon the accurate and recent surveys, is transmitted herewith. A map of this proposed work has never been published.

Attention is specially invited to the full and complete report of Assistant Engineer Nelles, which is transmitted herewith. This report contains a careful analysis of the work and useful tables showing the cost of construction. I think it will be valuable in preparing estimates for other works of this kind.

5. TENNESSEE RIVER BELOW RIVERTON, ALA.

This section of the river, 226 miles in length, is below most of the large tributaries. For this reason it carries at all times the greatest amount of water found in the river, and as the width in general is not

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excessive and the slope quite uniform and moderate the best navigation is found here. Indeed, for several months out of the year during the high-water season, this portion of the river is navigable by the largest classes of steamboats found on the Ohio and Mississippi rivers. During the low-water season, though no insurmountable obstacles exist, navigation is possible only by very light-draft boats. For this reason less attention has been paid in the past to the improvement of this portion of the river than has been given to the portions above.

For a great many years the only map that existed of this part of the river was the result of a reconnoissance made by a United States Coast Survey party in 1864–65, which map was prepared for military purposes. This map, while remarkably correct and accurate, considering the method of preparing it, was nevertheless not sufficiently in detail to be used as a basis for plans for permanent improvement.

The act of Congress of August 17, 1894, authorized a survey of this portion of the river to be made.

This survey has been completed and the notes have been plotted to a scale of 1 inch = 500 feet. The results form 63 charts 2 feet by 3 feet, and furnish a means of intelligently studying the river, which was not before possessed.

It is evident from these charts and from personal inspections of the river made at all stages that the principal improvement required can best be effected by dredging. A study of the charts shows that between Riverton Landing and Paducah there are more than sixty places at which dredging, or some equivalent improvement, is necessary. If it can be effected by dredging it will require the removal of more than 650,000 cubic yards of material, of which about 10 per cent is rock. Most of the material is gravel more or less cemented, but not so hard but that it can be removed with an ordinary dredge, with some little assistance by surface blasting.

Before this method of improvement is finally adopted as the approved project it is desirable that it should be sufficiently tested to determine what its cost will be and how permanent the improvement thus resulting will prove. In order to afford immediate relief to commerce, and at the same time to make a test of the value, cost, and permanency of dredging, a plant consisting of a dipper dredge, with $1\frac{3}{4}$-yard dipper, a towboat, and sufficient barges, was hired by contract and put at work on the lower portion of the river during the last low-water season.

Work was done at a number of points on the lower 30 miles of the river. A number of troublesome points were cut off and removed and cuts were made through several bad shoals. About 29,000 cubic yards of material was removed, at an average cost of 29 cents a yard. It was found that a dredge of this character could easily handle the material met with, with some little assistance from surface blasting. It remains to be seen whether the work done will be sufficiently permanent to justify a large amount in the future.

For a description of the actual work done and the localities and extent of the improvement, I would respectfully invite attention to the report of J. E. Hall, inspector of dredging, which is transmitted herewith.

It is proposed to continue dredging this year, using a plant belonging to the United States, which was started from the Muscle Shoals Canal at about the end of June, 1898, and which will work first at what is known as the Rockport Bar, near the mouth of Duck River. This place gives a great deal of trouble at low water, and is practically the head of navigation for large boats when the river falls to its lowest stage.

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REMOVAL OF SNAGS AND OTHER OBSTRUCTIONS.

About the middle of July, 1897, the United States snagging barge, which had been built for use on the river below Riverton, was sent out in tow of the steamer *Lookout*. It descended the river from Riverton to the mouth, removing as it went all snags, sunken logs, and similar obstructions which it could reach at the existing stage. It then returned up the river to Riverton, picking up those obstructions that were not found as it went down. The work ended December 6, 1897.

In passing over the river on these two trips, 455 snags were removed from the channel. Some of them were of enormous size, and it required the full power of the boat to handle them. In addition to these, 98 stumps and 848 sunken logs were removed, 8 old wrecks were broken and destroyed, 12 bowlders were removed, 2 car trucks were taken up, and 1 sunken barge was raised. In addition to this, the plant afforded valuable and necessary assistance to two large steamboats that were aground and unable to help themselves. There is no doubt that snagging in a river of this character is one of the most valuable improvements which can be effected for a moderate expenditure.

LIVINGSTON POINT, KENTUCKY.

Livingston Point is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee rivers, just above the mouth of the latter stream. This point and two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee, flowing from a southern latitude and rarely, if ever, troubled by ice.

The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River was rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio had washed through at high water.

Allotments from the appropriations for improving Tennessee River below Chattanooga, to be used at Livingston Point, Kentucky, at the mouth of said river, have been made as follows:

Act of September 19, 1890	$25,000
Act of July 13, 1892	25,000
Act of August 18, 1894	25,000
Total	75,000

A survey of Livingston Point was made in December, 1890, and, based upon the data thus obtained, a project for its preservation, with an estimate of $180,000, was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of the same month.

As stated in the Report of the Chief of Engineers, 1891, page 2256—

> The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush, carried well down the bank below the water surface, supplemented by a pile and stone dike along the crest of the weakest portion of the line, where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing, and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which, from the present indications, is likely to occur.

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The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone, in alternate layers. From low water to foot of dike broken stone will be carefully placed.

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1897, was $58,687.85, which has secured the completion of the dike on the Ohio side, across the "wash-out" near the extremity of the point, for a distance of 660 feet, and the protection of the bank for a length of 2,330 feet, extending 632 feet above the dike and 1,038 below it, the average width being 47 feet, all the work being done on the bank facing the Ohio River, so as to protect at once the low part of the exposed strip or "point," which was in danger of washing away. The work under contract for the shore protection of the Ohio bank of Livingston Point, by building a revetment of brush and stone riprap, was carried on in December, 1892, and from April to September, 1893, 9,092 cubic yards of stone, at $1.23 per cubic yard, and 274 cords of brush, at 94 cents per cord, being used, at an aggregate cost of $8,979.90. This contract was completed and terminated November 9, 1893, in accordance with its terms.

During an examination of Livingston Point, in July, 1893, it was found that unusually heavy ice and high water had greatly injured the point by causing the wearing away of the Tennessee bank to an alarming extent. It was recommended that the Tennessee bank be also suitably protected by stone riprap. This work was approved and authorized to be done by hire of service and purchase of materials in open market. During the months of August and September, 1893, and January, 1894, 9,116.48 cubic yards of stone was placed as riprap protection to the Tennessee bank, at a cost of $1.23 per cubic yard, $11,213.26.

In order to determine what further work was necessary for securing Livingston Point, a survey was authorized by letter of the Chief of Engineers, dated November 21, 1895.

A party was in the field, under Assistant Engineer D. W. Church, from December 9 to 19, 1895, and made a careful survey, covering 9½ miles on the Ohio River and 3 miles on the Tennessee. A comparison of the partial sections taken around Livingston Point with those taken in 1893 shows that no important change has taken place. The stone revetment which covers Livingston Point for a length of about 3,000 feet from its lower end was in fairly good condition and no trace could be found of the break reported in March, 1895. Some repairs are needed where the stone has been displaced in the revetment and where a pile is broken in the dike. The owner of Tennessee Island reported that the bank at the head of the island receded at the rate of 20 feet per year.

A recent examination of the head of Tennessee Island shows that the rate of recession is being fully maintained, and it will therefore become necessary to protect the head of this island in some way in order to prevent too great a widening of the opening between it and Livingston Point, which would result practically in transferring the mouth of the Tennessee River to this place, whereby the harbor of Paducah would rapidly fill up and be destroyed.

The last high water did some injury to the revetment at Livingston Point. Accordingly, a plant consisting of a towboat, quarter boat, and barges was sent to Livingston Point early in June, 1898, to make the necessary repairs. During the month 2,200 tons of stone was added to the revetment, and the work will be continued until the Point is reasonably secure.

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Money statement.

July 1, 1897, balance unexpended		$251,311.60
June 30, 1898, amount expended during fiscal year		115,769.08
July 1, 1898, balance unexpended		135,542.52
July 1, 1898, outstanding liabilities	*$11,723.93	
July 1, 1898, amount covered by uncompleted contracts	3,692.38	
		15,416.31
July 1, 1898, balance available		120,126.21
Amount (estimated) required for completion of existing project		5,362,939.81
Amount that can be profitably expended in fiscal year ending June 30, 1900		2,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations.

March 2, 1827	$200.00	March 3, 1881	$250,000.00
August 30, 1852	50,000.00	August 2, 1882	250,000.00
June 9, 1860	1,350.00	August 7, 1882	3,970.18
June 12, 1860	1,406.94	July 5, 1884	350,000.00
July 25, 1868	85,000.00	August 5, 1886	262,500.00
April 10, 1869	5,095.00	August 11, 1888	250,000.00
July 11, 1870	80,000.00	September 19, 1890	475,000.00
June 10, 1872	50,000.00	March 17, 1891 (transfer settlement)	3.91
March 3, 1873	100,000.00	July 13, 1892	500,000.00
June 23, 1874	100,000.00	August 18, 1894	400,000.00
March 3, 1875	360,000.00	June 3, 1896	50,000.00
August 14, 1876	255,000.00		
June 18, 1878	300,000.00		
March 3, 1879	210,000.00	Total	4,689,526.03
June 14, 1880	300,000.00		

Abstract of proposals for hire of dredging plant, opened at United States Engineer Office, Chattanooga, Tenn., Tuesday, August 31, 1897, by Maj. Dan C. Kingman, Corps of Engineers.

No.	Name and address of bidder.	Capacity of dredge per hour.	Rate per day of 8 hours.	Remarks.
		Cubic yards.		
1	Wm. A. Kirk, Madison, Ind.	30 to 70 yards per hour for gravel and bowlders.	$80	Bucyrus Dredge. Now under charter to Maj. W. H. Heuer, Corps of Engineers, until end of working season, and can not enter into new contract until after that time, which is indefinite.
2	Huse & Loomis Ice and Transportation Co., St. Louis, Mo.	Has dredged 100 yards of sand and mud per hour, but can not guarantee it.	$125 for first 30 days and $100 after expiration of 30 days.	Recommended for acceptance, as set forth in letter of this date, transmitting abstract.
3	H. S. Brown, Quincy, Ill.	Not definitely stated..	$70	Same objection as to bid No. 1 of Wm. A. Kirk.

Monongahela and Western Co., of Pittsburg, Pa., sent a telegram that a bid had been mailed by them at a rate of $125 per day, but the bid had not been received at time of opening.

Amount available, $20,000.

*Of the outstanding liabilities $6,022.18 is for wages due during the years 1878 to 1890, which remain unclaimed and probably never will be claimed.

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Abstract of proposals for constructing a dipper dredge, opened at United States Engineer Office, Chattanooga, Tenn., Saturday, April 2, 1898, by Maj. Dan C. Kingman, Corps of Engineers.

No.	Name and address of bidder.	Machinery placed in hull built by United States.	Machinery and hull complete.
1	Osgood Dredge Co., Albany, N. Y	$21,800	.....
2	The Bucyrus Co., South Milwaukee, Wis	14,425	.....
a3	John Featherstone's Sons, Chicago, Ill	15,850	$26,000
4	Delaware Construction Co., Wilmington, Del	No bid.	.....
5	Lake City Engineering Co., Erie, Pa	....do....	.....
6	G. H. Breyman & Bros., Toledo, Ohio	....do....	.....
7	The Coulter & McKenzie Machine Co., Bridgeport, Conn	....do....	.....
8	Lidgerwood Manufacturing Co., New York	....do....	.....
9	The Houston Construction Co., Philadelphia, Pa	....do....	.....
10	The Hartford Dredging Co., Hartford, Conn	....do....	.....
11	Vulcan Iron Works, Chicago, Ill	....do....	.....
12	Petersburg Iron Works Co., Petersburg, Va	....do....	.....
13	Morris & Cummings Dredging Co., New York	....do....	.....
14	H. S. Brown, Quincy, Ill	....do....	.....
15	Jno. K. MacDonald, Dunkirk, N. Y	....do....	.....
16	Vulcan Iron Works, Toledo, Ohio	....do....	.....
17	Excelsior Iron Works, Chicago, Ill	....do....	.....
18	Marion Steam Shovel Co., Marion, Ohio	....do....	.....
19	Toledo Foundry and Machine Co., Toledo, Ohio	....do....	.....

a This bid, No. 3, does not include the "spudding up" device required by paragraph 46 of the specifications. If furnished, $2,500 must be added to each bid.

Amount to be applied to construction of dredge complete, $20,000.

Commercial statistics of Tennessee River above Chattanooga, Tenn.

Articles.	Year ending December 31—				Estimated value 1897.
	1894.	1895.	1896.	1897.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Grain	55,116	45,433	51,153	38,931	$656,086.25
Iron ore	14,567	66,347	61,044	44,760	53,712.00
Lumber	7,957	14,995	16,819	9,799	73,492.50
Logs and wood	40,000	82,680	359,204	84,366	416,288.50
Live stock	1,089	1,249	4,996	1,066	66,625.00
Sand	1,225	1,500	80,403	26,358	17,659.86
Tan bark	27	.....	2,067	801	48,060.00
Flour	1,844	1,495	5,503	524	28,820.00
Railroad ties	.....	1,000	5,245	371	927.50
General merchandise	38,579	34,011	6,547	8,187	731,361.24
Cotton	14	27	258	1,553	217,420.00
Cotton seed	400	.....	30	316	4,740.00
Coal	.....	7,105	6,275	3,717	7,434.00
Hay	.....	1,827	5,652	1,866	29,856.00
Shingles	.....	5,250	64	235	4,700.00
Brick	.....	2,337	1,295	433	1,732.00
Tile	.....	.....	225	35	420.00
Marble	.....	.....	12,000	25,760	257,600.00
Peanuts	.....	.....	75	5	600.00
Hoop poles	.....	.....	2,900	.....	.....
Fertilizer	.....	.....	560	132	5,676.00
Tobacco	.....	.....	225	.....	.....
Produce	.....	.....	1,325	616	37,567.00
Staves	.....	.....	50	300	2,025.00
Stone	.....	.....	.....	6,200	31,000.00
Total	160,818	265,256	623,915	256,331	2,693,802.85

Number of passengers transported (1897), 13,989.

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Commercial statistics between Chattanooga, Tenn., and Florence, Ala.

Articles.	Year ending December 31—				Estimated value, 1897.
	1894.	1895.	1896.	1897.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Lumber	12,733	23,290	8,100	17,811	$133,582.50
Cotton	4,095	3,970	4,188	7,006	280,240.00
Live stock	921	234	798	1,497	93,562.50
Grain	7,559	13,716	13,165	33,399	562,773.15
Flour	3,288	3,874	4,143	2,922	160,710.00
Cotton seed	1,078	1,063	966	1,009	15,135.00
General merchandise	15,001	9,465	13,816	17,244	1,535,991.24
Logs and wood	122,011	1,287	40,693	86,320	244,858.50
Iron ore	6,664	46,610	36,686	33,760	40,512.00
Staves	.....	68	.....	.....	.....
Peanuts	.....	25	.....	.....	.....
Coal	.....	2,056	3,201	5,260	10,520.00
Hay	.....	47	376	1,646	26,336.00
Tan bark	.....	1,150	101	1,298	77,880.00
Sand	.....	8,984	2,892	17,370	11,637.00
Stone	.....	2,500	.....	5,702	28,755.00
Produce	.....	.....	602	616	37,567.00
Iron, pig	.....	.....	275	11,107	88,856.00
Brick and tile	.....	.....	204	402	1,608.00
Hoop poles	.....	.....	.....	2,410	12,050.00
Fertilizer	.....	.....	.....	332	14,276.00
Railroad ties	.....	.....	.....	311	777.50
Total	173,355	117,357	131,406	247,422	4,078,227.89

Number of passengers transported (1897), 31,846.

Commercial statistics between Florence, Ala., and Paducah, Ky.

Articles.	Year ending December 31—				Estimated value, 1897.
	1894.	1895.	1896.	1897.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Iron, pig	6,664	49,384	64,467	30,516	$244,128.00
Staves	2,251	27,296	29,079	28,894	195,034.50
Lumber	20,028	91,324	121,855	44,543	334,072.50
Cotton	4,437	16,317	4,605	6,804	952,560.00
Peanuts	640	8,910	3,598	3,875	465,000.00
Live stock	2,238	4,250	7,988	9,851	615,687.50
Hoop poles	880	68,052	1,604	3,717	18,585.00
Grain	9,990	24,283	2,948	11,977	201,812.45
Flour	4,510	6,600	5,085	2,158	118,690.00
Cotton seed	1,076	.....	2,330	1,425	21,375.00
Sand	4,922	14,437	4,700	.....	.....
General merchandise	22,089	100,072	134,059	17,971	1,560,140.00
Logs	192,012	112,482	125,634	43,825	219,125.06
Railroad ties	37,175	194,501	184,010	143,022	357,555.00
Coal	.....	92,335	127,024	31,500	63,000.00
Stone	.....	3,666	2,050	.....	.....
Tan bark	.....	34	172	693	41,580.00
Tobacco	.....	310	428	612	146,880.00
Wood	.....	34,060	41,684	8,584	8,584.00
Iron ore	.....	.....	151	.....	.....
Fertilizer	.....	.....	.....	200	8,000.00
Total	308,914	960,959	864,061	390,167	5,572,408.95

Number of passengers transported (1897), 24,789.

NOTE.—The falling off in tonnage and consequently in valuation during 1897, as compared with 1896, is due to the elimination of railway freights, which in former years had been ferried on the Tennessee River, but had been confined to a very small part of the river.

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List of steamboats (stern-wheel) plying on the Tennessee River above Chattanooga, Tenn.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Gladys and 3 barges	76	12	2.6	30.91	77
C. M. Fouche and 15 barges	93	14	2	61.12	300
Maud and 4 barges	79	16.5	3.2	23.30	900
Flora Swan and 7 barges	98	13	2.8	57.81	280
E. P. Dawson and 4 barges	60	10	2.8	29.30	124
Kingston and 4 barges	55	11	2.6	37.80	100
J. C. Warner and 1 barge	142	31.6	4.6	201.05	70
Clinton B. Fiske and 2 barges	100	18	3.4	79.89	80
Spring Hill and 9 barges	136	26.6	4	156.33	3,600
Ocoee No. 2 and 3 barges	85	12	2.6	51.54	165
Key City and 3 barges	80	15	3.1	59.45	150
Lora and 2 barges	70	12	2.5	44.32	200
J. P. Kindrick and 1 barge	112	20	3.7	128.71	80
J. W. Hart	41	7	2.1	5.63	
2 barges or flatboats					40
City of Knoxville and 1 barge	130	18	3	147.60	100
Onega and 3 barges	104.8	18	2.5	69.79	120
Lucile Borden and 2 barges	86	14	2.5	45.74	80
Telephone and 15 barges	93	19	2.6	97.47	450
Eclipse	39	9	3	9.72	
1 barge					20

In all, 19 steamboats of 1,337.48 tons burden net and 82 barges of 6,936 tons capacity.

List of steamboats (stern-wheel) plying on the Tennessee River below Chattanooga, Tenn., Alabama, and Kentucky.

BETWEEN CHATTANOOGA, TENN., AND FLORENCE, ALA.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Luke Pryor, jr., and 10 barges	103	18.5	3.5	124.56	2,500
Wm. Towle and 2 barges	90	16	3.5	63.86	700
Gladys and 2 barges	76	12	2.6	30.91	50
E. P. Dawson and 4 barges	60	10	2.8	29.30	124
Kingston and 4 barges	55	11	2.6	37.80	100
Mattie Ivey and 1 barge					15
J. C. Warner and 1 barge	142	31.6	4.6	201.05	70
J. P. Kindrick and 1 barge	112	20	3.7	128.71	80
Clinton B. Fiske and 2 barges	100	18	3.4	79.89	80
Bellevue and 2 barges	120	24	3.6	89.23	1,400
Spring Hill and 9 barges	136	26.6	4	156.33	3,600
W. J. Bryan	100	18	4	46.21	
Hattie McDaniels and 2 barges	90.5	18	2.5	90.63	1,200
Huntsville and 2 barges	125	24	4	89.99	550
B. F. Young and 26 barges	120	24.5	4	160.86	6,500
Ocoee No. 2 and 3 barges	85	12	2.6	51.54	165
Lora and 2 barges	70	12	2.5	44.32	200
City of Knoxville and 1 barge	130	18	3	147.60	100
J. W. Hart	41	7	2.1	5.63	
Onega and 3 barges	104.8	18	2.5	69.79	120
Lucile Borden and 2 barges	86	14	2.5	45.74	80
2 barges					600

In all, 21 steamboats of 1,693.95 tons burden net and 81 barges of 18,234 tons capacity.

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List of steamboats (stern-wheel) plying on the Tennessee River below Chattanooga, Tenn., Alabama, and Kentucky—Continued.

BETWEEN FLORENCE, ALA., AND PADUCAH, KY.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Mary N. and 10 barges	69	14	3	36.54	500
Ida and 10 barges	80.5	14.8	6.6	37.73	500
Louis Houck and 1 barge	210	37	6	620.48	1,700
Josie and 1 barge	146.2	28.6	4.8	233.70	1,700
Dolphin	135.8	22.8	4.8	156.16	.....
Cherokee and 8 barges	216.4	33.9	5.4	631.20	6,000
Spread Eagle and 5 barges	224.5	33.8	5.7	529.34	2,750
Fred Herald	244.6	34	7.2	900.58	.....
Frank Burnett	50.5	9.2	2.8	7.61	.....
Luke Pryor, jr., and 10 barges	103	18.5	3.5	124.56	2,500
Al Martin and 4 barges	112	23.6	4	96.68	2,000
Peter Honz and 19 barges	100	22	3	100	6,600
Dick Clyde and 6 barges	95.8	17.4	3.9	76.84	1,800
Kenton and 4 barges	105.2	33.4	5.2	153.08	2,000
John D. Lewis and 6 barges	148.2	28.2	4	266.41	2,700
City of Sheffield and 1 barge	133	35	5.5	329.74	300
City of Paducah and 1 barge	190	34	5.5	318.91	550
Clyde and 1 barge	175	33	5.2	335.96	300
Tennessee	.....	.....	.....	317	.....
Alda and 5 barges	121	21.2	4	78.80	2,800
Wash Honshell and 25 barges	157	28.6	4	134.99	12,500
John Barrett and 15 barges	124.8	31	5.5	187.23	10,500
Charley McDonald and 15 barges	147	30	4.5	259.52	10,500
Bellevue	120	24	3.6	89.23	.....
R. A. Speed and 11 barges	124	22	4.4	140.57	5,500
W. J. Bryan	100	18	4	46.21	.....
I. N. Hook and 3 barges	109.9	19.4	3	55.95	1,150
P. D. Staggs and 1 barge	161	28.6	4.4	261.23	100
Lula E. Warren and 2 barges	122	22.5	3.3	78.70	340
Fred Nelles	96	19	4	57.17	.....
Jacob Heatherington and 5 barges	128.8	24	4.2	192.77	3,000
Maggie Bell and 13 barges	95.6	18.4	3.6	52.81	4,700
Emma Cooper and 5 barges	95	25	3.3	79.10	1,210
Penguinn and 1 barge	80	16.6	3.4	60.68	421
Monie Bauer and 4 barges	73	17.5	3	45.36	2,400
Mayflower and 1 barge	137	44	5.5	718.04	250
Edgar Cherry and 1 barge	152	27.4	5	266.48	75
Jennie Gilchrist and 5 barges	100.5	18.5	3.8	74.48	650
Barge Buena Vista	.....	.....	.....	.....	500
City of Chattanooga	144	30	5.5	261.89	.....

In all, 39 steamboats of 8,408.76 tons burden net and 200 barges of 88,396 tons capacity.

REPORT OF MR. R. R. THACHER, SUPERINTENDENT.

KNOXVILLE, TENN., *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operations on the Tennessee River above Chattanooga, Tenn., for the fiscal year ending June 30, 1898:

On September 18 that part of the fleet and working party that was not needed on the French Broad River was sent to the Tennessee River. They stopped at Dickinson Island en route to Knoxville, where they removed 210 cords of snags, then proceeded to Knoxville, reaching there September 22, and began removing the old bridge piers that were put in the river during the civil war by General Burnside. The piers, twelve in number, were built of logs and filled with broken stone. The stone and logs were used in building up the dam at head of Knoxville Island. The channel from the County Bridge down to Maryville Railroad Bridge was cleared of loose rock and the rock used in reenforcing the dam that connects the islands.

At Maryville Bridge the channel was cleared of loose rock, and the old dam running from the island to the pier was built up with it. A longitudinal dam 350 feet long was built from the foot of the island, and to it three check dams were built, 140, 130, and 130 feet long, respectively. These dams were built to lengthen the fall and give a uniform velocity to the current. The stone from these dams was gotten from the bank about 2 miles below. It was broken up to be used in riprapping, and boated up to the dams.

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On November 6 the fleet left Knoxville for Caney Creek Shoals, cutting trees and removing snags en route. One quarter boat, one derrick boat, and two barges were left at Knoxville in charge of a watchman, as they were not needed in the work below. The following trees and snags were cut and removed:

Lyons Shoals.

	Number of trees.	Distance cut.	Number of snags removed.	Rock removed.
		Feet.		
Lyons Shoals	200	2,500	12	
Little River	225	2,500	5	
Post Oak	135	900	15	
Russells	35	400	.....	
Chota	325	2,000	40	
Coulters	550	2,000	120	
Little Tennessee River mouth	215	800	90	
Winding Shoals	1	.....	.....	
Sweetwater Pocket	350	1,000	2	35 cubic yards solid rock removed from channel.

Reaching Caney Creek Shoals November 27, work was begun at once cutting trees and removing the gravel bar at head of shoals with the steam derrick boat, using the Lancaster grapple, removing 2,100 cubic yards of sand and gravel, and placing same on dam. The dam at head of island was lengthened out 214 feet with 459 cubic yards of stone boated from quarry; the bank cleared of trees, and snags removed from channel.

Caney Creek Shoals.

Trees cut		1,075
Distance cut	feet..	4,700
Snags ramoved		180

On January 10 a rise put a stop to the work, and the fleet was towed to Kingston, Tenn., for safe moorings.

On February 5 the fleet and working party left Kingston for Chattanooga, cutting overhanging trees and removing snags as follows:

Places cleared of overhanging trees.	Number of trees cut.	Distance cut.	Number of snags removed.
		Feet.	
Half Moon Island	335	1,330	68
Bradys Bar	385	900	12
Washington Ferry	985	2,800	8
Garrison Bluff	620	2,300	70
Sale Creek	990	4,430	215
Soddy Creek	600	1,800	70
North Chickamauga	975	3,700	221

On February 24 the fleet left Chattanooga for Knoxville, Tenn., where it moored and has since been, undergoing general repairs.

Steamer *Long* had engines repaired, "lined up," furnace relined with fire brick, decks repainted, and hull whitewashed.

Two derrick boats had derricks repaired and decks and cabins repainted.

Four quarter boats repaired—guards, roofs, and floors repainted, and hulls whitewashed; general repairs.

Very respectfully, your obedient servant,

R. R. THACHER, *Superintendent.*

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. WINN, ASSISTANT ENGINEER.

CHATTANOOGA, TENN., *June 30, 1898.*

MAJOR: I have the honor to submit herewith a report of the work done under my supervision on the Tennessee River below Chattanooga for the fiscal year ending June 30, 1898.

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The plant which had been at work at the close of the last fiscal year in the vicinity of Florence, Ala., arrived ready for work at the "Skillet," 18 miles below Chattanooga, on July 1. From that time till work was suspended in March, 1898, a comparatively good season for work was had, only a few short delays on account of high water occurring during the time. The delays were principally on account of repairs necessitated by the lightness of the dredge as compared with the class of work to be done. The following work was accomplished:

"SKILLET."

The "Skillet" is a low-water obstruction caused by the constriction of the channel between a gravel bar, which extends from the right bank to within 300 feet of the other side, and a point from the left bank. The fall at this shoal is about 3 feet in 300, most of which was concentrated at the point from the left bank. At stages below 4 feet all boats were compelled to lay lines, which, owing to this point projecting so far out from the main alignment of the bank, was a difficult operation. The point consisted of sand and bowlders, the latter varying in size from one-tenth cubic foot to 2½ cubic yards, and forming about 90 per cent of the mass.

Three cuts were made with the dredge, beginning with the one next the bank, the material of which was cast over. The other cuts were placed on barges and deposited near the bank, in the pocket immediately below the work. The total number of cubic yards dredged was 6,113, at a cost of 21¼ cents per unit. The greatest difficulty in the work was controlling the dredge and barges in such swift water. The velocity of the current must have been about 9 miles an hour. The work resulted in a 75-foot increase in width of channel to a depth of 3 feet at low water, with the exception of four bowlders which were discovered during the lowest water of the season to be within 18 inches of the surface.

Besides the advantage of reduced current from increased width, the bank was straightened and left in such a shape that a line could be laid and a boat pulled through in a fourth of the time formerly required. I have seen boats with full crew work hard for two days getting through the "Skillet," and am satisfied that the same boat under the same conditions could get through in as many hours now.

"POT" AND "PAN."

While dredging was in progress at the "Skillet," improvement of channel from a 12-foot to 40-foot stage was also carried on at the "Pot" and "Pan." These obstructions are dangerous only at high stages, the low-water velocity being very slight. The river is confined between narrow, steep, rocky banks. The channel at low water is narrow but deep enough to admit of an easy discharge. The cross section does not increase in proportion to the rises in the river, and, as a consequence, there are swift currents at the obstructions with dangerous whirlpools on either side below. Boats are compelled to hug the banks, and for this purpose the right bank at the "Pan" and the left bank at the "Pot" were cleared of trees and dangerous bowlders. About 4 acres of clearing was done at the "Pan" and 2 acres at the "Pot," the aggregate cost being $22.72, or $3.46 per acre. The bowlders were closely drilled and heavily charged, and large pieces left after blasts were broken with sledges and thrown in the depressions in the banks. At the "Pan" 239 cubic yards of bowlders were blasted and leveled down. Cost, $172.19, or 72 cents per unit.

At the "Pot" 594 cubic yards were blasted and leveled down, at a cost of $436.22, or 72 cents per cubic yard.

WILLIAMS ISLAND.

At Williams Island the channel has been down the right slough, with Burris Bar as the one marked shoal, though for two-thirds the entire length of the island there is less than a 3-foot channel. The bottom in many places shows solid rock. On the left slough, with the exception of two short shoals, Blue Suck and Jackson Bar, there is not less than a 6-foot channel. It was therefore decided to improve the left slough.

Blue Suck consisted of a gravel bar and a series of rock reefs, the ledges being about 18 inches thick and inclined at an angle of 40 degrees to the water surface. The bank cut was cast over and the rest was boated to deep water.

	Cubic yards.
Gravel	4,411
Rock, etc	1,441
Total removed	5,852

Cost, $1,501.55, or 25¾ cents per unit.

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Two cuts were finished through, but the channel was left uncompleted to bring the dredge to Ross Towhead on a short rise. Ten days or two weeks more will be required to complete the channel.

Jackson Bar consists of solid reefs, dipping slightly up the river, and from 1 foot to 18 inches thick. A space 100 feet by 300 feet was drilled and blasted preparatory to removal with the dredge, but funds were exhausted before the dredge could be taken there.

The dredge *Harwood* could remove the blasted rocks in three weeks' time.

LOOKOUT SHOALS.

A small force worked a day on this shoal, rolling out bowlders that stuck above the bed of the river. The object was to make a temporary channel through which to boat coal to the dredge at Williams Island. About 6 cubic yards of bowlders were rolled out, by which the channel was made 6 inches deeper, or about 18 inches at low water.

BETWEEN GUNTERSVILLE AND HOBBS ISLAND.

Upon the request of the manager of the railway transfer boats that operate between Guntersville and Hobbs Island (about 21 miles), a small force was sent there with the necessary tools in skiffs to remove certain bowlders and points of reefs that had been obstructing the boats. The river reached a lower stage in the fall of 1897 than had before occurred in the transfer's existence, and developed bowlders from four to six tenths too shallow, that had never interfered before.

The bars at Beards Reef, Brown Creek, Paint Rock, and above the mouth of Flint River were worked on. The rock removed aggregated 23 cubic yards and cost $69, or $3 per cubic yard. The manager of the transfer reported the work to have been of great benefit to him.

ROSS TOWHEAD.

The most important shoal removed in extent as well as in good accomplished was that at Ross Towhead.

In the fall of 1891 a contract to excavate a new channel near the right bank was let to W. A. Kirk & Co. They worked for four seasons dredging, drilling, blasting, and removing rock with derrick boats. A portion of the wing dam from the head of the towhead toward the right bank was dredged, and the material deposited across the left slough, completely stopping up the old channel for low stages. The money allotted for the contract was exhausted before the new channel had been nearly completed. When I began operations there last fall there was only 1.1 feet of water over some of the ledges in the channel, and it then lacked three-tenths of being to extreme low water.

It was supposed that the blasting done by the contractor had so cracked up the rock that the dredge would excavate it without further blasting, and such an effort was made, but without success. An area 110 feet wide and 1,100 feet long had to be drilled and blasted. This was done in September and October, and in the latter month enough of the loose rocks were removed with a derrick to make a temporary channel through which to boat coal to the works below. Nearly 3,000 linear feet of holes were drilled and blasted, and the following material was removed. With the dredge, 6,251 cubic yards of rock, and 1,764 cubic yards of gravel; and with the derrick boat, 506 cubic yards of rock. Total amount, 8,521 cubic yards, at a cost of $5,225.84, including cost of drilling and blasting, subsistence and material expended, or 61.3 cents per cubic yard.

The sweeping of the channel that was done after work was suspended showed a clear channel to a depth of 2 feet at extreme low water and only a few loose rocks in the way of a 3-foot channel. These rocks had been loosened and kicked aside by the dredge, which was unable to pick them up in the dipper, and, owing to the stage of the water and its temperature at the time the work was finished, it was impracticable to remove them with the derrick. As far as solid bottom is concerned, the depth attained closely approximates 3 feet at extreme low water, as is shown by the fact that the dredge, drawing 3 feet, passed over the first cut during a time when the gauge showed not more than 0.5, and often less; and the rest of the cuts were made to the same depth.

The bottom consisted of solid reefs of hard, flinty limestone, the strata varying from 6 inches to 2 feet in thickness. It commonly came up in good-sized blocks, the largest removed measuring 1 by 12 by 15 feet, or about 6¾ cubic yards. The dredge was unable to lift it entirely out of the water. The material from the two extreme cuts was cast over on the two sides of the channel and served to hold the water straight in the channel. The remainder was boated, a part to form a 300-foot wing wall at the head of the channel and the rest was dumped in deep water.

Blasting and removing with dredge proved to be a very quick and economical

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method, as compared with former usages at this point. The contract price to Kirk & Co. was $1 for gravel and $3.75 for rock, against our cost of 61.3 cents when four-fifths of the material was rock. Making a liberal allowance for interest on plant and deterioration thereof, the cost per unit would not have exceeded $1.

On March 18 work for the season was suspended and the entire fleet was sent to Muscle Shoals Canal. Since that time I have been engaged in the office—calculating cross sections and making estimates of dredging below Riverton and assisting G. T. Nelles, assistant engineer, in designing masonry and gates for upper lock at Colbert Shoals.

Very respectfully, your obedient servant,

W. S. WINN,
Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. SYDNEY B. WILLIAMSON, ASSISTANT ENGINEER.

UNITED STATES MUSCLE SHOALS CANAL, ALABAMA,
June 30, 1898.

MAJOR: I have the honor to submit the following report of work done at Muscle Shoals Canal, under the appropriation for improving the Tennessee River during the fiscal year ending June 30, 1898.

The chief expenditure under this appropriation has been for repairs to the floating plant maintained for the improvement of the river.

DETAILED STATEMENT OF REPAIRS.

ABOVE CHATTANOOGA, TENN.

Electric launch.—Repairing engine and propeller, making awning and frame, stand for battery, painting hull and finishing inside.

BETWEEN CHATTANOOGA, TENN., AND DECATUR, ALA.

Dredge Harwood.—Repairing hull and machinery, making new spuds and spud casing; patterns, rivets, plates, brackets, rings, and bolts; making necessary castings and sawing necessary lumber.

Quarter boat.—Building cabin, making corner bands, tables, benches, and shelves; painting and sawing necessary lumber.

New barge.—Building barge complete and painting same.

Steamer McPherson.—Repairing, calking, and painting hull, repairing machinery, making new circles for wheel and new flanges.

Derrick boat.—Repairing hull, laying deck, making bolts, bands, stirrups, and rods; fitting pipe and repairing machinery, taking down derrick and boiler, building cabin, and painting.

BETWEEN DECATUR AND FLORENCE, ALA.

Steamer Colbert.—Building new hull, repairing machinery, and painting throughout; making braces, straps, patterns, valve stems, shaft for capstan engine, hog chains, valves, and bushing; casting grate bars, boxes, liners, cams, cam frames, cylinder rings, and bell; making new rudders, building furnace, putting up new breeching, fitting steam and exhaust pipes, repairing furniture, making new ice box, sawing and planing the necessary lumber.

Barge 211.—Docking, repairing, and calking hull; making bolts and corner bands, and painting.

Barge 212.—Docking, repairing, calking, and painting hull.

Barge 213.—Docking, repairing, calking, and painting hull.

Barge 206.—Docking, repairing, calking, and painting hull.

Quarter boat.—Docking, repairing, and calking hull.

Little Muscle Shoals.—Making minor repairs on dam at the head of Little Muscle Shoals, about 30 cubic yards of stone being used.

BELOW RIVERTON, ALA.

Steamer Lookout.—Remodeling cabin, repairing and calking hull, repairing wheel and rudders, machinery, boiler, and capstan engines; making hog chains, stirrups, bolts, and patterns; casting slides and grate bars; erecting auxiliary boiler and fit-

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ting breeching of same; repainting throughout; repairing furniture and making new dining-room furniture; sawing and planing the necessary lumber.

Snag barge.—Docking, repairing, and calking hull; making new spuds and casing; making bolts and points for spuds; painting hull and cabin.

MISCELLANEOUS.

Repairing boiler feed pump in shipyard, repairing and painting skiffs, repairing steam drill, making wedges, clamps, and windlass; making new skiffs, nozzles, clamp screws, calking irons and bolts; spinning oakum; sawing and planing necessary lumber, and repairing shipyard tools.

Very respectfully, your obedient servant,

SYDNEY B. WILLIAMSON,
Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

RIVERTON, ALA., *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operations carried on under my local charge at Riverton, Ala., connected with the construction of the Colbert Shoals Canal and its accessories, for the fiscal year ending June 30, 1898:

Owing to the comparatively small amount of money available, it was not attempted to begin the construction of the guard lock or to do any actual construction work along the line of the canal. Our active operations have been confined exclusively to the excavation of and the preparation for the construction of the entrance to the lift lock.

It was the original intention to complete the entrance during the fall and winter of 1897, but by reason of the dilatory action of the contractor for the earth excavation it was not found possible to more than complete this excavation and the protection of the sloping earth banks. Hence, so far as actual completed work is concerned, the lift lock and entrance remain in practically the same condition as described in my annual report for 1897.

WORK ON THE LIFT LOCK.

The only work done on the lock proper was to complete the pointing of the masonry, the setting of the guard-gate sill, the cutting of the grooves for the gate anchors, and some other miscellaneous cutting, the cost of all of which work was estimated and included in the statement of the total cost of the lock, submitted with the last annual report.

After the completion of the masonry of the lift lock it was decided to pave the area between the lower sills and the bottom of the filling wells with vitrified brick. Thirty thousand brick were purchased for this purpose at Evansville, Ind., and delivered at Riverton by the U. S. S. *Colbert*, at the following cost:

30,000 brick, f. o. b. Evansville, at $12 per M	$360.00
Pay roll, U. S. S. *Colbert*	194.13
Subsistence, U. S. S. *Colbert*	64.68
Coal consumed, U. S. S. *Colbert*	85.70
Total cost, 30,000 brick, at $23.50	704.51

CONSTRUCTION OF THE ENTRANCE TO THE LIFT LOCK.

Earth excavation.—Under authority granted May 10, 1897, bids for the excavation of the proposed entrance were received and opened on June 16 and on June 29 a final contract was entered into with John B. Neely, of Chattanooga, Tenn., for doing a certain part of the work in sixty days, at 26 cents per cubic yard.

Mr. Neely commenced work early in July with a small force and entirely inadequate plant, but signally failed, as will be shown hereafter, to complete the work in anything like the time agreed upon. Under the contract and specifications, all of the materials taken from the excavation were to be deposited in the embankments on each side of the lock, one of which was to be built up above extreme high water and to be utilized for grounds and buildings.

The maximum lift from excavation to embankment was 55 feet; the mean direct haul was 900 feet, and the maximum direct haul about 1,250 feet. The total quantity

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to be handled within the sixty days was estimated at 60,000 cubic yards, leaving between 12,000 and 15,000 cubic yards in the protective levee, to be removed under the same contract when the United States shall have completed the masonry and other work protected by it.

The material to be handled was fully and accurately described in the specifications, and the conditions were such as to call for the use of an extensive plant and unusually energetic work. The plan adopted by the contractor was to remove by teams with wagons and scrapers all of the material down to the so-called quicksand stratum, leaving the remainder to be taken out with dump cars, loaded by hand and operated by means of two stationary engines, one located at the extreme lower end of the excavation, to pull the cars out of the pit, and the other on top of the dump, to pull them to place.

The work done by teams was carried on successfully, and at a profit to the contractor, although at a much slower rate than the contract requirement. The work done with cars was very unsatisfactory, and carried on at a considerable loss of money to the contractor and a great loss of valuable time to the United States. The cars had a capacity of 2 cubic yards each, and were poorly designed and constructed. The tracks were too light for the weight carried, and the engines used were not sufficiently powerful for the work imposed on them. The natural result was that Mr. Neely soon found that he would not be able to complete his work in anything like the agreed time. He, consequently, under date of September 4, asked for an extension of time of thirty days, which was duly granted. On September 28 he made a second application, and was granted an extension of twenty-two days. On October 29 a third request was made, asking for an extension of fifteen days. This request also was granted, making December 1 the date of the termination of the contract instead of September 1, as originally contemplated.

The total quantity of earth handled was 60,837 cubic yards, of which 15,336 was done in July, 17,900 in August, 12,861 in September, 10,383 in October, and 4,357 in November and December. None of the materials encountered gave any particular or unusual trouble, except the blue sand stratum designated as quicksand. When first encountered this material was full of water and would not hold up the teams. After a few days' exposure, however, they could again work on it and take off a few inches. When shoveled into cars while wet it formed a loblolly, which stuck in the cars and had to be shoveled out at almost as great expense as to load it. If time had been allowed for this material to dry out or drain it could have been handled readily, but under the circumstances it proved a very difficult and expensive undertaking.

Rock excavation and dry protective slope walls.—In order to protect the side slopes of the excavation, which were left at a slope of 1 on 1, by special arrangement with the earth excavation contractor a small area of bed rock was stripped at the end of the north wall of the lock, a guy derrick set up, and the work of building the dry protective walls was commenced on September 27. As soon as the contractor was out of our way additional derricks were set up, and after getting fairly started this work was kept right up with the excavation, and the slopes were protected so that no serious slides occurred.

This method of doing the work was necessarily expensive and disadvantageous, in that we were able to work only a small force and could only excavate such rock as could be immediately built into the protective walls. The presence of the contractor confined us to a limited area and made it impossible to utilize our cable-way plant in disposing of the spoil.

The completed protective walls have a height of about 15 feet and a width of 10 feet.

The total quantity and detailed cost of this work was as follows:

3,200 cubic yards rock excavation, labor		$2,234.44
Explosives, coal, and plant		970.22
Total cost, 3,200 cubic yards, at $1		3,204.66
4,700 cubic yards dry protective walls, labor	$858.79	
Plant and coal	260.70	
Total cost, 4,700 cubic yards, at 23¼ cents		1,119.49
Grand total		4,324.15

As soon as the contractor removed his plant preparations were made for utilizing our cable-way plant for handling the rock excavation and for depositing the spoil immediately south of the entrance.

Just as our arrangements were completed, and before the cable way was used, an unusually early freshet occurred in the Tennessee River, during which a stage of 12.5

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feet was attained. The new portion of the protective levee settled badly, and on the night of December 24, when the river was highest, a break occurred at the upper end of the levee, filling the pit with water and causing an entire cessation of work. The break was about 50 feet wide, and the levee was washed out to a 2-foot stage on the gauge.

The river fell almost immediately to a low stage, and no difficulty would have been experienced in closing the break and continuing the work; but after serious consideration of the matter it was decided, in view of the cost of rebuilding the levee and pumping out the pit, and of the uncertainty of a continued low-water period, to cease all work until such a time as reasonable assurance could be had that the entrance could be completed without interruption. This decision was fully justified by subsequent happenings, which showed that the time necessary to complete arrangements for proceeding with the work would hardly have elapsed before a second freshet occurred; and since then we have had a number of similar freshets which would have flooded the work and caused more or less damage and expense.

Materials for entrance.—Early in the fall of 1897, while there was still hope of being able to complete the entrance during the season, arrangements were made for securing, or producing, all of the materials necessary for this purpose. It was estimated that in addition to the materials on hand approximately the following quantities would be required:

Stone	cubic yards..	8,000
Cement, natural	barrels..	5,000
Cement, Portland	do....	300
Sand	cubic yards..	1,750

Stone.—The class of masonry proposed contemplates a rough-pointed face, with one-half inch joints and beds cut back 10 inches. The backing is to consist of heavy rubble and concrete. For the cut-face stone the limestone and sandstone on hand, with the choice stone obtained from other sources, has been used. For backing it was decided to use the cheapest available stone, in connection with as much as possible of the suitable rubble and concrete stone from the rock excavation.

A careful canvass of the situation resulted in the conclusion that about 2,000 cubic yards could be purchased; that about 2,000 cubic yards could be obtained from the excavation, and that about 4,000 cubic yards could be obtained from other sources. Bids were asked for for the delivery at Riverton of 4,000 cubic yards of suitable stone. Those received from responsible bidders were considered too high, and the only really satisfactory bid, as regards price, was from parties without experience, money, plant, or open quarry. It was consequently decided, after an investigation of the limestone ledges at Cherokee, a short distance below the sandstone quarries heretofore operated by the United States, to reject all bids, and to produce the stone from these ledges by hired labor. The fact that the switch built by the United States in connection with the operation of the sandstone quarry had not been removed, and ran within 150 yards of the proposed opening, contributed largely to this decision.

The quarry consists of one 8-foot ledge and two 4-foot ledges of hard, flinty limestone, covered with from 4 to 16 feet of loose rock and earth. The stone is hard to cut and not particularly desirable in any way, but it will make excellent backing, and by selection will afford sufficient face stone and coping for our purposes. The quarry was opened up in October, and although comparatively little stone was actually produced, it is thought that sufficient has been stripped, ready for quarrying, to furnish all that will be needed for the entrance. It was intended to quarry and ship all of the stone to Riverton at once, but the cold weather in December developed the fact that the green stone was seriously affected by freezing when the temperature was below 18 degrees, so it was decided to cease all work at the quarry until active operations were resumed at the lock site.

The approximate cost and quantity of work done is shown below:

Prospecting:		
Labor	$49.35	
Materials	4.28	
		$53.63
Plant, derricks:		
Labor	286.50	
Materials, etc.	298.11	
Tracks, etc.:		
Labor	219.88	
Materials, etc	10.30	
		814.79
Quarry superintendent		281.08

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Stripping:		
Labor	$1,232.46	
Materials, etc	141.66	
		$1,374.12
Quarrying, 351 cubic yards:		
Labor	400.00	
Materials	20.00	
		420.00
Loading, 349 cubic yards:		
Labor	155.45	
Freight, etc	486.80	
		642.25
Quarry privilege, 351 cubic yards, at 7 cents		24.57
Knox blasting system royalty, 28 cars, at $1.20		33.60
Total		3,644.04

In addition to the above, 1,680 cubic yards of limestone, quarried by the original contractors for the lock, was purchased at the Keller quarry on the river, 25 miles above Riverton; 121.52 cubic yards of scabbled sandstone on the ground at Riverton was purchased of the receiver for the contractors, and 33.36 cubic yards of limestone shipped to Riverton for the main lock construction, but owing to injury by frost not accepted, was purchased of the Fossick Company.

The Keller stone was taken at the quarry, so it was necessary for us to load and transport it to Riverton. The existing quarry plant was repaired and renewed for the purpose of loading the United States barges, which were towed to Riverton by the U. S. S. *Colbert*, where the stone was unloaded onto the cars of the Northern Alabama Railway and switched by them to the lock site.

The work done by the steamer *Colbert* in handling this stone over the Colbert and Bee Tree Shoals is worthy of special mention, and indicates to what extent the river might be used in low water with a properly designed plant. Between July 20 and August 20 the *Colbert* made twenty-five round trips with stone, bringing down forty-three loaded barges, carrying a total of 1,668 cubic yards, weighing, approximately, 3,650 tons, giving an average of 140 tons per trip, or 85 tons per barge. The following statement shows the number of trips made, the number of barges in each tow, the cubic yards on each barge, and the readings of gauges No. 1 and No. 4 when trips were made:

Detailed statement of work done by the Colbert in towing stone from the Keller quarry to Riverton.

Date.	Barges.	Cubic yards.	Gauges.	
			Riverton.	Upper lock.
1907.				
July 20	212	31.79	3.3	2.3
21	206	26.01	5	2.7
22	213	42.54	5	2.7
24	211	29.45	4.8	2.6
26	206	36.18	4.2	2.4
27	211	52.42	4.8	2.8
28	212, 213	83.47	6.7	3.4
29	211	67.27	9.6	4.1
30	212, 213	110.33	9.1	3.7
31	211	57.11	6.7	3
Aug. 1	212, 213	94.87	5	2.6
2	211	31.35	3.8	2.3
3	212, 213	65.06	3.1	2
4	210, 211	66.14	2.4	1.8
5	212, 213	74.30	2	1.7
6	210, 211	63.97	1.9	1.6
7	212, 213	65	2	1.6
8	209, 210	70.97	1.7	1.5
10	213	82.54	2	1.7
12	210, 211, 212, 213	139.66	2.6	2
14	212, 213	95.58	3.2	2.1
16	210, 211	93.56	2.3	1.7
17	212, 213	94.63	1.6	1.5
18	210, 211	68.69	1.2	1.4
20	210, 212, 213	75.14	.8	1.2
	Total	1,668.05		

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The channel over the shoals is narrow and crooked, making it necessary to double trip on low stages. When the gauge read less than 2 feet the steamer and barges rubbed the bottom frequently, but never hard enough to do serious damage.

The detailed cost of this work and of all stone purchased was as follows:

1,668 cubic yards rough limestone, at 80 cents		$1,334.40
Labor, loading, etc., quarry, at 70 cents		1,169.37
Labor, unloading, etc., Riverton, at 30 cents		509.98
Switching 136 cars, at $2		272.00
Towing—		
Colbert's crew	$784.00	
Subsistence	181.52	
Coal	229.05	
		1,194.57
1,668 cubic yards, at $2.70		4,480.32
121.52 cubic yards scabbled sandstone purchased, at $4		486.07
33.26 cubic yards limestone purchased, at $2.25		75.73
1,822.88		5,042.12

Sand and cement.—Bids were also taken for delivering the necessary sand and cement at Riverton. The contract for cement was awarded to the Western Cement Company, of Louisville, Ky., for 5,000 barrels of Louisville cement, at $1.07 per barrel, and for sand to M. N. Smith, of Spruce Pine, Ala., for 1,500 cubic yards of washed bank sand; 750 barrels of cement had been delivered at the time work was shut down.

Stonecutting.—The specifications for this work were as follows:

"The face of the walls is to be rough-pointed, with projections not exceeding 1½ inches below low water and not exceeding three-fourths inch above low water. The beds and joints are to be one-half inch for 10 inches back from the face. The coping will be tooth-axed and show margin draft."

It was decided to use sandstone for facing the north wall, both limestone and sandstone for the south wall, and limestone for coping.

A force of cutters was organized in September, and all the best cutters available were kept employed on the work until late in December, when it was discovered that the unseasoned stone from Cherokee, of which about 150 cubic yards had been cut, was being shattered by the frost. At that time practically all of the suitable sandstone and purchased limestone on hand had been cut. The total amount of stone cut, as well as the details of cost, is given below:

Amount and cost of stonecutting for entrance to lift lock at Riverton, Ala., during the fiscal year ending June 30, 1898.

Kind of stone.	Stonecutters' wages alone.							
	Number of stones.	Total cost.	Cubic yards.	Cost per cubic yard.	Square feet of surface cut.			
					Face.	Beds and joints.	Total.	Cost per square foot.
Straight face:								
Limestone	685	$2,088.10	1,289.61—	$1.61+	9,942.79	31,681.98	41,624.77	$0.05 +
Sandstone	387	923.10	570.47—	1.62—	4,231.03	17,763.97	21,995.00	.04 +
Total	1,072	3,011.20	1,860.08—	1.62—	14,173.82	49,445.95	63,619.77	.047
Curved face:								
Limestone	14	51.00	29.93—	1.70+	229.66	775.35	1,005.01	.05 +
Sandstone	134	457.40	240.15+	1.90+	1,640.31	7,623.03	9,263.34	.049
Total	148	508.40	270.08+	1.88+	1,869.97	8,398.38	10,268.35	.049
SPECIAL STONES.								
Arch and culvert:								
Limestone	17	$137.40	28.88+	$4.76—	279.60	765.74	1,045.34	$0.13 +
Power house:								
Limestone	30	73.60	26.43—	2.79—	223.54	1,084.15	1,307.69	.056
Sandstone	44	86.20	39.08—	2.21—	334.17	1,626.81	1,960.98	.04 +
Total	74	159.80	65.51—	2.44—	577.71	2,710.96	3,276.67	.048
Pipe opening:								
Limestone	8	56.40	9.38+	6.01+	84.64	94.24	178.88	.31 +

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Amount and cost of stonecutting for entrance to lift lock at Riverton, Ala., during the fiscal year ending June 30, 1898—Continued.

SPECIAL STONES—Continued.

Kind of stone.	Stonecutters' wages alone.							
	Number of stones.	Total cost.	Cubic yards.	Cost per cubic yard.	Square feet of surface cut. Face.	Beds and joints.	Total.	Cost per square foot.
Wheel pit:								
Limestone	47	$122.20	56.65—	$2.16—	418.15	1,887.68	2,305.83	$0.05 +
Sandstone	37	94.40	53.82—	1.75+	370.50	1,753.33	2,123.83	.04 +
Total	84	216.60	110.47—	1.96+	788.65	3,641.01	4,429.66	.048
Total special	183	570.20	214.24—	2.66+	1,710.60	7,211.95	8,922.55	.06 +
Total for stonecutters' wages	1,403	4,089.80	2,344.57	1.74+	17,754.39	65,056.28	82,810.67	.049
Total cost for labor, scabblers, and foremen		3,018.89		1.28+				.038+
Total cost for plant and repairs		357.04		.15+				.004+
Total cost for stone		7,504.00		3.20				.090+
Grand total	1,403	14,969.73	2,344.57	6.38+	17,754.39	65,056.28	82,810.67	.181

The cost for plant, labor, other than stonecutters, and stone has not been divided for the various kind of stone cut, and the costs given above are the totals and averages for the year.

There yet remains to be cut for the entrance 225 cubic yards of coping and about 650 yards of face stone.

Masonry.—At the time the work was shut down the masonry work had just been actually begun. About 50 feet of foundation excavation had been prepared at the end of the south lock wall, and about 50 cubic yards of masonry and concrete had been placed.

Quite extensive preparation had been made for pushing this work. Suitable tracks for conveying materials to the derricks had been laid, and 5 stiff-leg derricks, each covering a length of 100 feet of wall, were in process of erection. These derricks are set on top of the dry protective walls at an elevation of about 25 feet above the bottom, and so arranged as to be useful for removing the excavated rock and for storing materials, as well as for building. With all the materials at hand it is thought that the masonry can easily be completed in three months.

The cost of these preparations, as well as the materials accumulated, was as follows:

Setting derricks:		
Labor	$577.55	
Materials	272.00	
		$849.55
Setting up cableway:		
Labor	350.28	
Materials	90.25	
		440.53
Weeping tubes		62.50
Sand, 97.5 cubic yards		131.72
Cement, 850 barrels		1,147.50
Unloading and handling cement and sand		66.61
Setting masonry		73.89
Total		2,772.30

Embankments.—Since closing down the work a small force has been constantly engaged getting the embankments into shape and protecting them with Bermuda grass. The large percentage of quicksand in the fill makes it difficult to hold the embankments in shape and to prevent the washing out of the quicksand. The plan finally adopted, and which gave excellent results, was to surface the slope with a depth of 1½ inches to 2 inches of clay; then plant the Bermuda roots in rows, along with a considerable quantity of oats; then cover the whole with a thin layer of clay, finally completing the work by pounding and tamping it thoroughly with the backs of shovels. At this writing the slopes are completely covered by the oats, and the Bermuda grass is growing and spreading out rapidly.

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The embankment on the south side of the lock is completed up to a height of 26 feet above the lock walls and affords a space 100 by 400 feet for buildings, etc.

On the north side the top height is about 12 feet above the lock walls.

A system of waterworks has been erected, consisting of a small pump, connected with a 6,000-gallon tank on the south embankment. Pipes with suitable hose connections are extended the full length of each embankment for the purpose of watering and caring for the sodded slopes.

The following summary gives the total amount and cost of work done during the fiscal year:

Superintendence and office expenses:		
Services	$3,895.43	
Miscellaneous	326.37	
		$4,221.80
Watchmen and care of plant:		
Labor	1,315.88	
Miscellaneous	55.20	
		1,371.08
Gauges		133.37
Miscellaneous cutting and work on main lock, including last report:		
Labor	321.82	
Miscellaneous	386.30	
		708.12
Brick for paving in main lock		704.51
Care of embankments:		
Labor	1,223.26	
Miscellaneous	54.05	
		1,277.31
Expenses due to high water:		
Labor	634.52	
Miscellaneous	123.92	
		758.44
Additions, repairs, and renewals of plant:		
Labor	199.32	
Miscellaneous	1,133.98	
		1,333.30
Entrance to lift lock:		
Miscellaneous preparations	279.07	
Entrance excavation, 60,837 cubic yards	14,215.86	
Entrance excavation, supervision, and inspection	649.27	
		15,144.20
Rock excavation, 3,200 cubic yards:		
Labor	2,234.44	
Miscellaneous	970.22	
		3,204.66
Dry protective walls, 4,700 cubic yards:		
Labor	858.79	
Miscellaneous	260.70	
		1,119.49
Masonry—preparation and materials:		
Labor	1,068.33	
Materials	1,703.97	
		2,772.30
Stone purchased, 1,822.88 cubic yards		5,042.12
Stone quarried and delivered at Riverton, 350 cubic yards		3,644.04
Stonecutting, 2,345 cubic yards, at $3.19		7,465.73
Total		48,900.47

Construction materials on hand.—The following statement gives the quantity and value of construction materials on hand at the end of the fiscal year, available for the construction of the entrance:

Sand, 275 cubic yards	$397.50
Cement, 852 barrels	1,214.11
Miscellaneous	62.50
Cut stone, 2,345 cubic yards	14,969.73
221.52 cubic yards scabbled sandstone	886.07
349 cubic yards rough limestone (Cherokee)	3,644.04
307.36 cubic yards rough limestone (miscellaneous)	975.33
Total	22,149.28

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POWER HOUSE AND OPERATING MACHINERY FOR LIFT LOCK.

In connection with the construction of the entrance, it was necessary to determine the size of openings to be left in the walls for the escape of the tail water from the turbine wheels to be installed for furnishing the power for operating the gate machinery and for pumping out the lock for repairs, etc., and it was desirable at the same time to design and construct at least the foundations for the proposed power house. A very complete study and discussion of the questions involved resulted in the conclusion that the size of the power plant and the consequent size of the openings would depend practically upon the necessity of emptying the lock quickly for repairs rather than on the power necessary for the operation of the gate machinery.

Based on these conclusions, sketches were prepared, and approved by you, for a power house of the following description:

The building is located 8 feet south of the face of the south entrance wall and 15 feet west of the guard gate recess corner. Its outside dimensions are 19 feet north and south by 23 feet east and west, giving a turbine floor, at reference 25, 14½ by 17 feet, and a machinery floor, at reference 38, 16 by 20 feet. Provision is made for installing two 25-inch turbine wheels, one 24-inch by 15-foot accumulator, and two suitable power pumps. The wheel pit is 8 by 12.5 feet and connects with the water in the lock entrance, through an arched opening 8 feet wide by 7 feet high. An opening of this size will provide for the disposal, without loss of power from this source, of the tail water from two 25-inch turbines, working under a head of 15 feet and furnishing 105 horsepower. Under greater heads greater power can be realized, but the efficiency of the wheels will not be so great.

The specific design of the building was not attempted, but it is proposed to provide against the complete submergence of the building during extreme high water.

OPERATING POWER FOR GATE AND VALVE ENGINES.

At your suggestion the matter of operating the hydraulic gate and valve engines by direct pressure from a tank or reservoir, located at an elevation on the hills adjoining the lock site, was investigated and reported on in detail August 28, 1897.

The result of this investigation was, briefly, as follows:

By elevating a tank about 50 feet above a hill situated 4,100 feet east of the lock and 900 feet south of the canal right of way, a sufficient head to insure an effective engine pressure of 100 pounds per square inch can be secured. This plan entails the construction of about 1 mile of 10-inch water main, the erection of a 20,000-gallon water tank, and the installation of a small pumping plant.

The size of the necessary engines will be, approximately, as follows:

Lower gate engine cylinder, 20½ inches diameter by 9-foot 6-inch stroke.

Upper gate engine cylinder, 13½ inches diameter by 9-foot 6-inch stroke.

Valve engine cylinder, 11½ inches diameter by 32-inch stroke.

This method appears to have many advantages over operating by pump pressure, either direct or through accumulators, and should be given full and careful consideration before finally deciding the matter.

WATERSHED AND DRAINAGE.

The matter of providing proper drainage facilities for taking care of the rainfall which may find its way into the canal has been the subject of a careful study and investigation, and was reported on at length under dates of September 6, 1897, and April 1, 1898. The conclusions reached and suggestions offered, which have met with your approval and that of the division engineer, were as follows:

That the Buerki-Ziegler and the McMath Catchment Basin formulas, by reason of their form and of the circumstances attending their derivation, are better suited to the determination of the maximum rate of flood discharge for the Colbert Shoals Canal Basin than any of the other numerous formulas in use; that for areas of the nature and extent of this one the coefficient "C" can be given a value of 0.50 in both formulas; that the maximum rate of flood discharge from the district, due to a rainfall at the rate of 3 inches per hour, can be safely and reasonably taken at 3,050 cubic feet per second.

Based on the maximum rate thus obtained and the configuration of the basin, it was suggested to allow the discharge directly into the canal of as much area as could be safely cared for by its reservoir capacity and the flow through the valves at the lift lock, and to carry the drainage from the remaining area directly to the river by means of suitably disposed culverts constructed under the canal; the inner ends to be so protected by levees as to prevent any backwater from the river finding its way into the canal through them.

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Under this plan only the five lower creeks, or individual drainage districts, are to be provided with culverts. For an assumed maximum velocity of 6 feet per second these culverts will have cross-sectional areas of from 55 to 225 square feet. The discharge from 3,000 acres will be carried by the canal and from 6,500 acres by culverts to the river.

CANAL AND EMBANKMENT SECTIONS.

The high water of March, 1897, gave rise to a set of conditions very different from those under which the original project for the canal was prepared, and made it necessary to reconsider the whole matter of the construction of the canal and its embankment, as well as the guard lock.

After a thorough oral discussion of the matter with you I submitted, on February 15 and 23, 1898, reports embodying this discussion and describing a proposed form of cross section and manner of constructing the canal.

The canal section contemplates a bottom width of 118 feet, a low-water width (reference 33.5) of 150 feet, and side slopes of 2 to 1, properly protected by riprap paving. At reference 37.5, on the river side, a berme or towpath 10 feet wide is left. The embankment begins at the outer edge of the towpath, and has a height of 3 feet above high water of 1897. The top width is 10 feet and the side slopes are 3 to 1. It is proposed to make a continuous earth embankment and, except for a low core wall through the center of the embankment where it occupies the bed of the river, not to use any masonry.

It is found that there will be a great deficiency in the material for building the embankment. This is to be provided for by widening the canal where the deficiency makes it necessary. This widening will result in an increase of nearly 40 per cent in the average width of the canal, and is so distributed as to make five long pools, ranging from 300 to 500 feet wide. To put this plan into effect will involve the purchase of at least 125 acres of additional right of way.

GUARD LOCK.

The plans and project for the construction of the guard lock prepared by Mr. D. W. Church, under the direction of Capt. Theo. A. Bingham, Corps of Engineers, United States Army, and submitted to you in March, 1896, were complete in every detail, and for the conditions then imposed left little to be desired.

These plans have been under consideration at various times, but as no funds were available for the prosecution of the work it was thought advisable to defer final action on their adoption. This delay has since proved quite fortunate, for, by reason of the new conditions established by the flood of 1897, it has been necessary to reconsider the whole matter.

As a preliminary to the final design for the guard lock, the question of the form and type of gates to be used has been thoroughly canvassed and reported on to you, as follows:

March 29, 1898: A discussion of the various forms and types considered suitable for use as main gates for the guard lock, recommending the adoption of steel, vertically framed, straight mitering gates. This recommendation met with your approval, and on your recommendation was approved by the Chief of Engineers, United States Army, April 12, 1898.

July 1, 1897: A report and design for caisson guard gates 30.5 feet high, 12.5 feet wide, and 86 feet long.

April 12, 1898: A second report upon the same design.

April 15, 1898: A discussion of the stability of the caisson gates above referred to.

April 21, 1898: A discussion and preliminary designs for caisson guard gates, 21 feet high, with argument in favor of the adoption of this height.

April 28, 1898: A reconsideration of the guard-gate question, with a preliminary design for steel, vertically framed, straight mitering guard gates, 20 feet clear height above sill.

The whole matter was submitted to the Chief of Engineers, United States Army, with the recommendation which was approved May 24, 1898, that steel, vertically framed, straight mitering guard gates about 21 feet high be used.

The settlement of these preliminary questions, and your decision to use the form of operating engines and valves adopted for the lift lock and to provide for a possible maximum flood height of 3 feet above that of 1897, made it possible to proceed with the plans and project for the guard lock. This was done at once, and on June 13, 1898, complete plans and project were submitted for your consideration, and on June 18, 1898, forwarded by you to the Chief of Engineers, United States Army, with the recommendation that they be approved and adopted.

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The main features of the design are as follows:

The lock is of the same general form and horizontal dimensions as the lift lock, viz:

	Feet.
Length between hollow quoins	350
Width	80
Depth on sills at extreme low water	6

The main-lock chamber walls are 39½ feet high above the sills, and so designed that for the combined pressure due to water standing at reference 67.0 behind and at reference 63.0 in front of the walls, and due to dry earth level with the top of the walls (calculated by the Rankine formula) that the center of pressure will always fall at or inside of the outer limit of the middle third of the base.

The entrance and other retaining walls are designed to resist earth pressure alone, and for the same restrictions regarding the center of pressure as the main walls.

Owing to the comparatively small head under which this lock will be operated, it was not thought advisable or necessary to extend the filling and emptying culverts the full length of the main walls. The filling culverts have consequently been simply carried around the upper main gates, having one 8 by 7½ foot opening above and three 4½ by 4½ foot openings immediately below the upper gates. The emptying culverts are constructed around the lower gates and have one 8 by 7½ foot opening above and below the gates.

Straight, vertically-framed mitering gates, constructed of steel, are to be used throughout. The main gates are 38½ feet high above the sills; the upper guard gates are 20 feet high above the sill, and the lower guard gates are 15 feet high above the sill.

The entrance from the river is similar in form to that designed by the Board of Engineer Officers, United States Army, and adopted for the lift lock. The walls are 21 feet high above the sills. The south wall is in the extension of the south lock wall, and goes out to the river, a distance of 260 feet from the guard-gate recess.

The north wall is curved to the left on a radius of 40 feet through 25 degrees, and then extends straight to the river. It has a total length from the guard-gate recess of 98 feet. Both walls end in a solid masonry pier 15 feet in diameter. The entrance from the canal is formed by curved walls of 50 feet radius, beginning 5 feet from the lower guard-gate recess. These walls are of the same height as the main walls.

The extreme length of the structure is 901 feet. The plans above described have not yet received the formal approval of the Chief of Engineers, United States Army.

Meteorological.—In May, 1897, the United States Weather Bureau established a rain gauge at Riverton, which has since been regularly read by some one connected with this office and reported to the proper authorities.

The following is the record of the monthly and exceptional rainfalls for the year:

Monthly and exceptional precipitations at Riverton, Ala., during fiscal year.

Month.	Total.	Greatest fall.		Remarks.
		Amount.	Date.	
1897.	*Inches.*	*Inches.*	*Inches.*	
July	2.18	0.68	18	Rain gauge established May 24, 1897.
August	5.47	2.00	6	
September	0.00	.....	.....	
October	1.70	1.67	11	
November	6.58	2.00	16	
December	8.62	1.59	3	
1898.				
January	8.28	2.21	15	
February	2.64	1.00	27	
March	4.36	1.00	29	
April	4.44	2.45	19	
May	3.05	.70	20	
June	.90	.32	18	
Total	48.22	.....	.....	

General.—A fair idea of the extent to which the river is made use of by steamboats can be gained by an examination of the following statement, which gives the names of all the boats landing at or passing Riverton during the year, the number of trips

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made to Riverton and over the Colbert and Bee Tree Shoals, also the lowest stage at which the passage over the shoals was made:

List of boats and trips made to Riverton, Ala., and over Colbert Shoals, Tennessee River, during year ending April 30, 1898.

Name.	Number of trips made—		Lowest stage over shoals, Riverton gauge.
	To Riverton.	Over shoals.	
			Feet.
Bessie Smith	18	36	1.9
Charley McDonald	4	6	7.9
City of Chattanooga	4	8	6.8
City of Paducah	17	4	2.4
City of Savannah	1	.....	.....
City of Sheffield	20	6	2.7
Clyde	22	10	5.1
Colbert (U. S. S.)	30	60	0.8
Dolphin	1	2	14.8
Gladys	9	18	1.9
Goldenrod (U. S. S.)	6	6	7.0
Jacob Hennings	1	.....	.....
Jake Hetherington	1	.....	.....
Kingman (U. S. S.)	3	6	0.0
Lookout (U. S. S.)	2	1	.....
Lora	1	1	—0.6
Luke Pryor	1	1	3.0
Lyda	1	1	0.5
McPherson (U. S. S.)	1	2	8.4
Mayflower	5	.....	.....
P. A. Speed	1	.....	.....
P. D. Staggs	17	2	2.1
Tennessee	3	2	0.7
Wash. Haunschell	1	.....	.....
Wm. Towle	1	1	1.9
W. J. Bryan	19	32	—1.9
Total, 26 steamboats	200	205	.....

Very respectfully, your obedient servant,

G. T. NELLES,
Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. J. B. HALL, INSPECTOR OF DREDGING.

CHATTANOOGA, TENN., *January 25, 1898.*

MAJOR: I have the honor to submit the following report of dredging done on the Tennessee River, below Riverton, Ala.:

The plant in my charge was furnished by the Huse & Loomis Ice and Transportation Company, of St. Louis, Mo., under contract with the United States, and consisted of the following pieces:

One dredge, old-style clutch machinery, with 1¼-yard dipper; 1 towboat, used in moving plant and as a quarter boat; 1 small steamer for handling scows; 2 dump scows, capacity 90 yards each; 1 fuel barge; 1 harbor boat for storing explosives, and other necessary appliances. This fleet reported for duty at Paducah on Monday, October 4. Work was done at the following places, given in their sequence up the river from Paducah:

Head of Tennessee Island, mouth of Guess Creek, Little Chain, bar below Gilbertsville Bridge, foot of Twenty-seven Mile Island, foot of Three Mile Island, and head of Twenty-seven Mile Island.

HEAD OF TENNESSEE ISLAND.

This obstruction consisted of a cemented gravel reef, running out from island into channel, and several detached lumps of cemented gravel. Five days were spent in removing this obstruction. Three cuts were made, averaging about 300 feet in length. Amount of material removed, 1,005 cubic yards and 2 large logs.

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MOUTH OF GUESS CREEK.

At this place loose bowlders lying on a hard bottom caused steamers drawing more than 30 inches to rub during the low-water season. About 60 yards of bowlders were removed, leaving the channel clear—our soundings showing 4 feet at low water.

We passed over Big Chain Bar, since there is sufficient water over it for packet boats, and to improve it for towboats would require a large amount of dredging, as the bar is a very long one.

LITTLE CHAIN.

This obstruction comprises two bars—one at the head of Little Chain and one at the foot—and a large number of loose rocks lying in channel. The bar at the foot was composed of cemented gravel. Two cuts were made widening the channel about 50 feet. Material removed, 1,050 cubic yards; time consumed here, six days.

The upper bar consisted of loose gravel. The dredge here, in two days, moved 1,800 cubic yards of material, making a cut 500 feet in length. Two days were spent in removing rocks from channel. One of these rocks contained 72 cubic feet. Their removal afforded a great relief to navigation.

BAR BELOW GILBERTSVILLE BRIDGE.

This bar was near the middle of the river and was formed by a sunken coal barge. Here we dredged 1,450 cubic yards of material, taking out what remained of the barge. Time spent, three days.

FOOT OF TWENTY-SEVEN MILE ISLAND.

The channel here is down the left shore, from which were a number of gravel spurs. These spurs were caused by logs and drift piles, which accumulated gravel. We dredged off these spurs and removed the logs. Material dredged, 1,550 cubic yards; time, five days.

FOOT OF THREE MILE ISLAND.

The channel, in crossing the river here, passes over a bar, which gets very shallow at low water. The dredge made three cuts through this bar, excavating a channel about 90 feet in width and 600 feet in length. Material removed, 4,400 cubic yards; time, eight days.

HEAD OF TWENTY-SEVEN MILE ISLAND.

This place has given steamers more trouble than any other on the river below Hamburg. There were two bars—one above and the other below the Government light. The lower bar was about 700 feet in length and 150 feet in width. The head of this bar was about 600 feet below the Government light. Here the current sets out strong from the left shore. To safely pass this place it was necessary for a steamer to lay a line ashore. We removed this bar, taking out 10,770 cubic yards of loose and cemented gravel. Time, nineteen days. The upper bar is just above the Government light. The cuts through this are about 1,200 feet in length. We were dredging here when the river rose, stopping the work for the season, leaving it in an unfinished condition. Two cuts were made here, giving a width of 45 feet. The amount of material removed was 6,400 cubic yards of cemented gravel.

The total amount of material handled by this plant during the season aggregates 28,965 cubic yards. Cost per unit, including blasting and inspector's services, 29.3 cents.

Very respectfully, your obedient servant,

J. E. HALL, *Inspector of Dredging.*

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

D D 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal has been constructed in accordance with the project approved in 1872 and modified in 1877. It is divided naturally into two parts, locally designated as the upper and lower divisions, the two being separated by 8 miles of river navigation.

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The upper, or Elk River section, is a lateral canal which overcomes the Elk River Shoals; it has two locks, with a total lift of 23 feet. It consists of an upper pool, formed by a rock-fill dam, extending from the lower end of Browns Island diagonally across the river and then parallel to the shore to the first lock. Below the first lock is the canal trunk, 1 mile in length, and below the second lock is a dredged channel extending through Gilchrist Chute. The total length of the Elk River division is 5 miles.

The lower division consists of an upper pool, one-half of a mile in length, formed by an extension of the canal embankment above Lock 1, and of eight intermediate pools and nine locks, numbered from 1 to 9, beginning at the upper end. The total length is 14½ miles, and the total lift is 85 feet. The maximum lift of any lock is 13 feet, at Lock 6. The locks are all of the same size. They have a total length of 380 feet, a clear width of 60 feet, and a length between hollow quoins of 300 feet. The culverts are all 4½ by 6 feet. With the exception of Lock A, which may be operated by hydraulic machinery, hand power is used for maneuvering. The average time of lockages is seventeen minutes.

Although the canal is naturally divided into two sections, as before described, yet for the purpose of operation, care, and administration it is regarded as a single work.

In the allotment for operating and care of Muscle Shoals Canal for the year ending June 30, 1898, $4,000 was provided for cleaning and painting the lock gates of the eleven locks and the metal work of the aqueduct. In order to remove the old paint, rust, and scale, a sand blast was extemporized from machinery on hand and was mounted on a barge for convenience in moving it about. This was used with great success. It would clean the metal down to a perfectly bright surface, removing all rust and paint from pits and depressions, and would leave it in the best possible condition to receive the new coat.

As the new surface of metal quickly became covered with a film of red rust if allowed to remain unprotected, the painting was made to follow the cleaning very quickly, the best red lead being used. About 45,000 square feet of surface was cleaned and painted, the cost being for cleaning about 2.3 cents per square foot.

A detailed description of the device used for creating the sand blast is contained in the report of Assistant Engineer Williamson, which is transmitted herewith. The entire work of cleaning and painting has not yet been completed, but it will be rapidly and cheaply done with the material and appliance now on hand.

During the flood of March, 1897, a portion of the dam between Browns Island and Lock A was partially destroyed; a breach in it was also made at its junction with the lower end of Browns Island, and the dam was further weakened and threatened with future injury by the large amount of drift which lodged and hung upon it. A special allotment of $2,000 was made for these extraordinary repairs, and the breaches have been closed and the drift removed from the dam.

The expense of caring for a work as extensive as this is and exposed as it is to so many destructive agencies is very much greater than the cost of operation alone. The United States has at this place 11 locks, 1 steel aqueduct, 16 miles of canal trunk and embankment, 30 miles of telephone line, 15 miles of railroad, 1 dry dock, 1 sawmill, 1 machine shop, 1 carpenter shop, 9 lock-masters' houses, 11 assistant lock-masters' houses, and 19 other buildings, quarters, mess halls, storehouses, etc., and 128 acres of land at the locks and along the towpath, besides the

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dredge, steamboat, derrick boat, naphtha launch, and barges, with tools and appliances. To keep all this in proper repair and to prevent it from deterioration and from destruction involves a considerable annual expense. The canal could be operated for ten times the amount of commerce that at present uses it without greatly increased cost.

In the report of Assistant Engineer Williamson, which is transmitted herewith, a very thorough analysis of the expenditures and costs is given, and special attention is invited to it. From this report it appears that the average cost of operation and care of a lock has been about $70 a month.

Fifteen streams of varying size empty directly into the canal, though none of them are very large; yet at every freshet they bring down a certain amount of sediment, and bars are constantly forming in the canal opposite their mouths. At the entrance to both divisions of the canal also a large amount of silt accumulates at very high water, and constant dredging is therefore required to keep the canal cleared. A Bucyrus dredge of the elevator type, having a chain of 24 buckets, each of 5 cubic feet capacity, is employed on the canal for this purpose. During the past year it has fortunately been unnecessary to do any very large amount of dredging. About 11,000 cubic yards in all of material has been removed during the year, the unit cost being about, as heretofore, 3 cents a cubic yard.

The sawmill, dry dock, machine shop, and carpenter shop, which have been located at the canal, partly because it was the largest and most important work on the river, and partly because of the water power which existed there, have been of great value, not only in making the necessary repairs upon the canal itself, but also for repairing the fleet employed upon the whole river. The work done at these various shops is described elsewhere in this report and is given in detail in the report of Assistant Engineer Williamson.

The telephone line, 30 miles in length, which extends from Florence, Ala., along the entire canal, crossing the river to reach the upper division, has been of great value, and is a necessary adjunct to the operation and care of the canal. It has been kept in proper repair, the average cost of the maintenance being about $14.50 per mile.

A steam railway of 4-foot gauge extends along the entire lenth of the towpath of the lower division. With necessary sidings, it is 15 miles in length. It is absolutely necessary to the maintenance of the canal, and is very convenient in its operation.

The canal is a lateral one, extending along an unnavigable portion of the river. For a very considerable portion of its length the land side is a rocky bluff, and no road runs parallel to the canal except the railroad. If a break occurs in the embankment of the canal, at least one level is emptied, and the break can not be reached with material for its repair by water. The railroad furnishes the only convenient and possible means of transporting stone, earth, and other material for such repairs to the embankment. The locomotives are also used to assist tows in passing through the canal. The trunk being narrow and crooked, it is extremely difficult for a large tow to pass through with its own power. The rolling stock consists of two 18-ton locomotives, 2 coaches, a small springless open car, 1 wrecking car, and 6 flat cars, besides 2 hand cars, 1 velocipede, and 1 inspection car. Necessary repairs have been made to the rolling stock in the shops during the past year.

The average number of miles run by the trains is about 2,000 per month, at a cost of about 42 cents per engine a mile. The annual cost

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of maintaining the track has been about $630 a mile, the greatest item of expense being for new ties, of which an unusually large number has been required during the past year.

In all cases where work of repair and construction of plant has been done at Muscle Shoals Canal for other sections of the river the cost of this work has been carefully ascertained and charged to the proper appropriations.

Much care has been devoted during the past year to ascertain the unit cost of operating and maintaining the various subdivisions of the canal plant, and it is not thought that they can be reduced below the present point without permitting the plant to deteriorate, thus involving largely increased expenditure in the future. It is worthy of note that the total cost of operation and care of this extensive work, exposed as it is to so many causes of deterioration and injury, is only slightly in excess of 2 per cent of the sum expended in its construction. I think that this will compare very favorably with the cost of maintaining and operating any of the great works on land or water in the country.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
July 1, 1892	45,232.90
July 1, 1893	60,975.19
July 1, 1894	63,772.63
July 1, 1895	64,793.11
July 1, 1896	62,707.46
July 1, 1897	67,979.55
Total	437,252.88

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation (indefinite), to be applied to current expenses in operating the Muscle Shoals Canal, from July 1, 1898, to June 30, 1899.

Amount required for fiscal year ending June 30, 1899	$64,000.00
Balance available, remaining from allotment of preceding year	1,131.83
Additional allotment required for fiscal year ending June 30, 1899	62,868.17

To be expended as follows:

One assistant engineer, at $200 per month	$2,400.00
One overseer, at $100 per month	1,200.00
One overseer of dredging, at $85 per month	1,020.00
One clerk, at $100 per month	1,200.00
One machinist, at $90 per month	1,080.00
Eleven lockmasters, at average of $75 per month	9,900.00
Eleven assistant lockmasters, at average of $35 per month	4,620.00
One carpenter, at $80 per month	960.00
One locomotive engineer, at $65 per month	780.00
Two stokers, at average of $50 per month	1,200.00
Forty laborers, at average of $25 per month	12,000.00
Dredge and towboat crews	9,600.00
Subsistence	6,300.00
Repair of dredge, plant, material, and contingencies	11,740.00
Total for year	64,000.00

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Detailed expenses incurred for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1898.

Month.	Office and administration.			Operating, care, repairs, etc., Locks A and B and 1 to 9.				Grand Total.
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.	
1897.								
July	$275.00	.....	$275.00	$4,306.91	$545.50	$619.08	$5,471.49	$5,746.49
August	275.20	$15.00	290.20	4,847.72	508.05	182.08	5,532.85	5,823.05
September	278.65	4.65	283.30	4,623.92	578.45	835.74	6,038.11	6,321.41
October	279.94	2.07	282.01	4,641.98	582.40	874.12	6,098.45	6,380.46
November	284.10	.....	284.10	4,078.68	578.77	1,816.61	5,974.01	6,258.11
December	275.00	.....	275.00	3,660.34	578.91	813.84	5,052.59	5,327.59
1898.								
January	283.49	.....	283.49	4,330.01	600.50	849.13	5,779.64	6,063.13
February	275.00	.85	275.85	3,871.65	532.90	470.54	4,875.09	5,150.94
March	285.00	5.40	290.40	3,594.73	525.62	713.98	4,834.27	5,124.67
April	298.37	1.75	300.62	3,934.27	544.71	485.21	4,964.19	5,264.71
May	295.25	.70	295.95	3,949.02	559.37	1,202.29	5,710.68	6,006.63
June	295.00	16.55	311.55	3,963.46	493.99	631.88	5,089.33	5,400.88
Total	3,400.50	46.97	3,447.47	49,802.58	6,624.17	8,998.95	65,420.70	68,868.07

Abstract of proposals for furnishing one year's supply of fresh meat at Muscle Shoals Canal, Alabama, opened at United States Engineer Office, Chattanooga, Tenn., at noon, February 5, 1898.

No.	Name and address of bidder.	Beef per pound.	Mutton per pound.	Pork per pound.
		Cents.	*Cents.*	*Cents.*
1	Crow Bros., Florence, Ala	9	8	6
a2	Chas. J. Halter, Florence, Ala	6¾	7	6½

a Lowest bid; acceptance recommended.

Twelve circulars inviting bids were sent out and but two received.

ADVERTISEMENT.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tenn., March 19, 1898.

Sealed proposals in duplicate for furnishing fresh butter, eggs, onions, and potatoes will be received at this office until noon, Monday, April 18, 1898, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office.

DAN C. KINGMAN,
Major, Corps of Engineers.

Abstract of proposals for furnishing one year's supply of fresh butter, eggs, onions, and potatoes at Muscle Shoals Canal, Ala., opened at U. S. Engineer Office, Chattanooga, Tenn., at noon, April 18, 1898.

No.	Name and address of bidder.	Eggs, per dozen.	Butter, per pound.	Onions, per bushel.	Potatoes, per bushel.
a1	J. T. Jones, Center Star, Ala	$0.09	$0.20	$1.10	$0.90
2	J. B. McPeters, Killen, Ala	No bid.	No bid.	No bid.	No bid.
3	Harrison Bros., Killen, Ala	....do	....do	....do	Do.
4	C. J. Halter, Florence, Ala	....do	....do	....do	Do.
5	Lucas & Kilburn, Florence, Ala	....do	....do	....do	Do.
6	Andrew Jackson, Center Star, Ala	....do	....do	....do	Do.

a Only bid received.

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Statement of traffic through the Muscle Shoals Canal during the calendar year ending December 31, 1897, compared with traffic during years ending December 31, 1894, 1895, and 1896.

Articles.	Year ending December 31—				Estimated value, 1897.
	1894.	1895.	1896.	1897.	
Steamers ..... number..	37	35	114	87	.....
Barges ..... do....	30	40	61	102	.....
Rafts ..... do....	37	21	7	4	.....
Miscellaneous craft ..... do....	40	21	11	24	.....
Tonnage ..... tons..	5,891	4,973	15,230	10,730	.....
Lumber ..... do....	3,127	1,598	1,049	2,956	$18,475.00
Cotton ..... do....	.....	.....	239	178	24,920.00
Cotton seed ..... do....	.....	.....	227	102	1,530.00
Grain ..... do....	62	173	553	189	3,184.65
Flour ..... do....	141	500	57	.....	.....
Live stock ..... do....	.....	.....	9	10	628.00
Coal ..... do....	295	80	38	14	28.00
Iron ..... do....	.....	195	238	.....	.....
General merchandise ..... do....	1,201	1,329	940	370	33,300.00
Logs ..... do....	19,522	1,674	540	150	750.00
Hoop poles ..... do....	.....	.....	.....	1,150	5,750.00
Total ..... do....	24,348	5,540	3,880	5,119	88,565.65
Passengers ..... number..	566	254	2,057	2,569	.....

Number of lockages (1897), 1,842.
The above is exclusive of supplies carried by Government steamers.

REPORT OF MR. SYDNEY B. WILLIAMSON, ASSISTANT ENGINEER.

UNITED STATES MUSCLE SHOALS CANAL, ALABAMA, *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operating and care of the United States Muscle Shoals Canal during the fiscal year ending June 30, 1898:

GENERAL DESCRIPTION OF CANAL.

The construction of Muscle Shoals Canal was in accordance with plans approved in 1872 and modified in 1877. The system is naturally divided by 8 miles of navigable river into two parts, known as the upper and lower divisions, embracing, respectively, the canalization of Elk River Shoals and Big Muscle Shoals. The upper division is composed of two locks separated by 1 mile of canal, an upper pool 2½ miles long, and a dredged channel about 1 mile in length below the lower lock. The lower division includes nine locks and 14.5 miles of canal. The average width of both divisions is 90 feet.

In the following table are shown the principal and special features of the canal:

Principal features of Muscle Shoals Canal.

Designation.	Lock walls.				Lock gates.				Filling culverts.		Emptying culverts.	
					Upper.		Lower.					
	Height above lower sills.	Height above floor.	Bottom width.	Top width.	Kind.	Material.	Kind.	Material.	Number.	Dimensions.	Number.	Dimensions.
Elk River Shoals Canal:	*Feet.*	*Feet.*	*Feet.*	*Feet.*						*Feet.*		*Feet.*
Drift sluice..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lock A	17.6	19.75	11	4	Swing	Iron..	Swing	Iron..	2	4½ by 6	2	4½ by 6
Lock B	19.25	20.12	11	4	Swing	Iron..	Swing	Iron..	2	4½ by 6	2	4½ by 6
Big Muscle Shoals Canal:												
Lock No. 1....	16.65	18.62	10.5	4	Swing	Iron..	Swing	Iron..	2	4½ by 6	2	4½ by 6
Lock No. 2....	13.09	16	7.5	4	Swing	Iron..	Swing	Iron..	2	4 by 6	2	4 by 6
Lock No. 3....	18.5	20.3	10.5	5	Swing	Iron..	Swing	Iron..	1	6 by 8	1	6 by 8
Lock No. 4....	17.1	19.75	10.5	5	Swing	Iron..	Swing	Iron..	1	6 by 8	1	6 by 8
Lock No. 5....	18.94	21.25	11	4	Drop..	Wood	Swing	Iron..	2	4½ by 6	2	4½ by 6
Lock No. 6....	19.98	23.75	11	4	Drop..	Wood	Swing	Iron..	2	4½ by 6	2	4½ by 6
Aqueduct....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lock No. 7....	18.96	20.75	11	4	Drop..	Wood	Swing	Iron..	2	4½ by 6	2	4½ by 6
Lock No. 8....	17.08	19	10.5	4	Drop..	Wood	Swing	Iron..	2	4½ by 6	2	4½ by 6
Lock No. 9....	17.5	19.5	10.5	4	Drop..	Wood	Swing	Iron..	2	4½ by 6	2	4½ by 6

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Principal features of Muscle Shoals Canal—Continued.

Designation.	Valves.			Depth on miter sills.		Lift.	Available length.	Total length.	Clear width.	Underlying material.	Material.	Cubic yards.
	Location.	Number.	Dimensions.	Upper.	Lower.							
Elk River Shoals Canal:			*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
Drift sluice	.....	...	.....	.....	.....	.....	.....	40	.....	Masonry.	Wood	.....
Lock A	Wall..	4	4½ by 6	5.4–13.2	5	4.22–12.2	285	407	60	Rock ..	Limestone.	4,280
Lock B	Wall..	4	4½ by 6	6	2.5–19.3	18	285	407	60	Rock ..	Limestone.	6,096
Big Muscle Shoals Canal:												
Lock No. 1	Wall..	4	4½ by 6	*a* 5	5	*b*10	285	411	60	Rock ..	Limestone.	4,300
Lock No. 2	Wall..	4	4 by 6	7.25	5	6.34	285	409	60	Rock ..	Limestone.	2,951
Lock No. 3	Wall..	4	3½ by 7	7	5	11.50	285	453	60	Rock ..	Limestone.	6,764
Lock No. 4	Wall..	4	3½ by 7	6.5	5	10.61	285	445	60	Rock ..	Limestone.	6,082
Lock No. 5	Wall..	4	4½ by 6	7	5	11.94	285	378	60	Rock ..	Limestone.	4,715
Lock No. 6	Wall..	4	4½ by 6	7	5	12.98	285	378	60	Rock ..	Limestone.	2,884
Aqueduct	.....	...	.....	.....	.....	.....	.....	900	60	Rock ..	Limestone and steel.	3,070 *c*2,000,000
Lock No. 7	Wall..	4	4½ by 6	7	5	11.95	285	378	60	Rock ..	Limestone.	3,533
Lock No. 8	Wall..	4	4½ by 6	6.9	5	10.07	285	378	60	Rock ..	Limestone.	3,495
Lock No. 9	Wall..	4	4½ by 6	7	*a* 5	9.75	285	378	60	Rock ..	Limestone.	4,645

a Minimum. *b* Maximum. *c* Pounds.

For administrative purposes the following classification has been adopted and will be adhered to in describing the nature and cost of the work performed during the past year:

Canal: Operating and care of locks; maintenance of embankment; dredging and care of canal trunk.
Railway: Maintenance of way; rolling stock, repairs, etc.; operating expenses.
Telephone line: Operation and repairs.
Machine shop: Operation and repairs.
Sawmill: Operation and repairs.
Buildings: Improvements and repairs.
Quarters and grounds: Care of, etc.
Floating plant: Operation and repairs.
Dry dock: Operation and repairs.
Miscellaneous.

CANAL.

Operating and care of locks.—The most important work in connection with the care of the locks that has been done during the year has been cleaning and repainting the iron lock gates and a portion of the aqueduct. The metal was thoroughly cleaned with a sand blast and painted with red lead. A general description of the sand-blast plant may be of interest, inasmuch as it has proved to be quite efficient and was simply constructed, for the greater part, of material on hand. The machinery was placed on a barge, provided with suitable shelter, and consists of a boiler, a 12 by 14 inch stationary engine, and two 9 by 9 inch Clayton air compressors, coupled directly to the engine. The compressed air passes from the compressors into an iron cylinder 18 inches diameter and 4 feet long, and from this into a second receiver made of an old vertical boiler. From the latter, three blast pipes pass under and are connected to the sand drums by valves for regulating the admission of sand to the blast pipe. To the extremity of each blast pipe is attached 25 or 30 feet of hose, each hose having attached a three-eighths-inch nozzle made of tool steel. The sand drums are iron cylinders, 18 inches diameter and 4 feet long, supported in a vertical position by wooden frames. There are six of them, grouped in pairs, the units

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of each pair being connected independently to the same blast pipe, so that by closing the valve of one it may be refilled while its mate is in use. A large wooden hopper extends over all of the drums; into this sand is screened and admitted by valves into the drums as needed. Finally, to equalize the pressure in the drums, compressed air is admitted at their tops by a half-inch pipe leading from the receiver. The sand is thoroughly dried before it is used and every precaution is taken to keep moisture from the hopper and sand drums.

The following is a statement of cost to June 30, 1898:

Erecting plant, repairs, etc	$713.34
Building sand shed, drying furnace, loading, transporting, and drying sand	386.20
Cleaning and painting lock gates and aqueduct	1,064.24
Total cost to June 30, 1898	2,163.78
Total number of square feet cleaned and painted	44,522
Cost per square foot	$0.023

DETAILED STATEMENT OF REPAIRS ON LOCKS.

Each lock is attended by a watchman, who, in addition, polices and improves the surrounding United States property.

Lock A: The timber cribbing supporting the hydraulic machinery was replaced with masonry and general repairs made to the machinery. The timber crib work supporting the wing wall above the lock was also removed and replaced with masonry. The gravel behind the walls was taken out to a foot in depth and replaced with earth. Grass and trees were then planted.

Lock B: Making new walk ways for gates and removing log from valve.

Lock 1: Cleaned mud from above miter sills, made new screens for culverts, and cleaned and painted 3,540 square feet of gates.

Lock 2: Cleaned and painted 2,416 square feet of gates.

Lock 3: Made new gate platforms; cleaned mud from above miter sills; cleaned and painted 2,660 square feet of gates.

Lock 4: Repaired walk way, valve covers, and spar platform; removed mud from above miter sills; cleaned and painted 2,854 square feet of gates.

Lock 5: Repaired valves and drop gates; cleaned and painted 2,290 square feet of gates.

Lock 6: Repaired drop gates, valves, and sluiceway; put in new bedplates for spar pinions; cleaned and painted 2,353 square feet of gates.

Lock 7: Repaired valves and drop gates; cleaned and painted 2,465 square feet of gates.

Lock 8: Repaired drop gates; cleaned and painted 1,863 square feet of gates.

Lock 9: Cleaned and painted 225 square feet of gates.

Aqueduct: Cleaned and painted 23,854 square feet.

Miscellaneous: Making patterns and casting extra pinions and racks for drop gates; putting in valves at Four Mile and Six Mile creeks; locking boats and barges through.

TABLE A.—*Unit cost of operating and care of locks.*

Month.	Last year.			This year.			Average 2 years.		
	Cost per lock.	Vessels through canal.		Cost per lock.	Vessels through canal.		Cost per lock.	Vessels through canal.	
		No.	Cost per vessel.		No.	Cost per vessel.		No.	Cost per vessel.
July	(a)	34	(a)	$73.72	16	$50.68	$73.72	25	$50.68
August	(a)	11	(a)	46.72	8	64.25	46.72	9½	64.25
September	(a)	3	(a)	55.75	3	204.42	55.75	3	204.42
October	(a)	16	(a)	62.11	2	341.62	62.11	9	341.62
November	$61.36	18	$37.50	54.02	2	297.14	57.69	10	167.32
December	66.85	42	17.50	62.69	12	57.47	64.77	27	37.48
January	66.58	61	12.00	93.02	10	102.32	79.80	35½	57.16
February	56.12	53	11.65	87.91	14	69.07	72.01	33½	40.36
March	83.32	19	48.23	73.80	26	31.22	78.56	22½	39.72
April	54.87	24	25.14	82.81	17	53.59	86.84	20½	39.36
May	65.87	15	48.30	99.60	26	42.14	82.73	20½	45.22
June	57.85	14	45.45	87.93	23	41.62	72.89	18½	43.79
Average	64.10	26	30.72	73.34	12½	112.96	69.46	19½	94.28

a Not itemized.

Total number of lockages, 2,330.

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Maintenance of embankment.—The embankment has been inspected daily, and all leaks detected immediately repaired. A large amount of broken stone and other material has been used in widening and strengthening the bank on sections 2 to 9, inclusive, and 25 to 27, inclusive. The exterior slope was graded and sodded at Locks 6 and 9 and on section 25. A cofferdam was built in front of the drift sluice above Lock A and the drift sluice extensively repaired. At the same time the channel leading from the sluice to the river was blasted out and widened. A portion of the work on the wing wall above Lock A was charged to care of embankment. The work performed consisted in quarrying, transporting and cutting stone and laying masonry. The embankment has also been kept clear of weeds and underbrush.

Dredging and care of canal trunk.—The dredge has been used very little during the past year. It has been necessary, however, to dredge at entrance of the lower division and at the mouth of several of the streams emptying into the canal.

TABLE B.—*Amount and cost of dredging.*

Month.	Last year.			This year.			Average, 2 years.	
	Classification.	Cubic yards.	Cost.	Classification.	Cubic yards.	Cost.	Cubic yards.	Cost.
			Cents.			*Cents.*		*Cents.*
July	Mud	9,100	2				9,100	2
August	Mud, gravel, and stone.	12,010	2½				12,010	2½
September	Mud and clay	10,750	2½				10,750	2½
October	Mud, clay, and gravel.	6,700	4½				6,700	4½
November	do	3,150	13½				3,150	13½
March	Riprap and clay	330	19	Mud	6,850	3	3,590	11
April	Mud	9,225	4½	do	3,800	3	6,512	3.87
May	do	10,000	3½				10,000	3½
June	Mud and rock	285	21				285	21
Total		61,550			10,650		62,097	

The flood of March, 1897, partly destroyed about 300 feet of the longitudinal dam between Browns Island and Lock A, and cut off about 75 feet from the lower end of Browns Island. All of these breaks have been repaired and several weak points strengthened; in addition, the dam was cleared of drift.

TABLE C.—*Unit cost of maintenance of canal trunk and embankment.*

Month.	Last year.			This year.			Average, 2 years.		
	Cost per mile of canal.	Vessels through canal.		Cost per mile of canal.	Vessels through canal.		Cost per mile of canal.	Vessels through canal.	
		No.	Cost per vessel.		No.	Cost per vessel.		No.	Cost per vessel.
July		24		$11.77	16	$13.98	$11.77	25	$13.98
August		11		25.72	8	61.08	25.72	9½	61.08
September		3		48.87	3	187.50	48.87	3	187.50
October		16		59.79	2	568.04	59.79	9	568.04
November	$36.36	18	$32.32	43.69	2	415.09	40.02	10	223.70
December	8.48	42	3.24	19.67	12	31.14	14.07	27	17.19
January	9.65	61	2.53	31.22	10	59.33	20.43	35½	30.93
February	4.87	53	1.49	25.08	14	34.04	14.97	33½	17.76
March	37.32	19	31.85	7.24	26	5.29	22.53	22½	18.57
April	46.09	24	30.73	4.56	17	5.10	25.32	20½	17.91
May	34.95	15	37.28	7.14	26	5.20	21.04	20½	21.24
June	10.83	14	12.38	17.47	23	10.63	14.15	19½	11.50
Average	23.63	26	19.98	25.19	13½	116.37	26.56	19½½	99.12

TELEPHONE LINE.

Operation and repairs.—A number of breaks in the telephone line, caused by falling trees and high winds, have been repaired. One hundred new poles have been put up between Lock 6 and Florence, Ala. All instruments on the line have been cleaned and the necessary repairs made.

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TABLE D.—*Cost of operation and maintenance of telephone line.*

Month.	Cost per mile of telephone line for 80 miles.		
	Last year.	This year.	Average, 2 years.
July	$1.78	$0.46	$1.12
August	1.50	.66	1.08
September	1.58	.33	.95
October	1.58	.26	.92
November	1.17	.26	.71
December	.29	.26	.27
January	.16	.42	.29
February	.42	.73	.57
March	.53	.48	.50
April	4.42	.83	2.62
May	.78	3.45	2.11
June	.33	.58	.45
Average	1.21	.73	.97

RAILWAY.

Maintenance of way.—The narrow-gauge (4-foot) railroad track along the towpath of the lower division, has been extensively repaired and improved. Six miles of track—viz, from Lock 1 to between Locks 2 and 3, and from Lock 6 to Lock 9—have been reballasted with chert; 4,645 new cross-ties have also been put in the track. The broken stone removed from the roadbed has been used for riprapping the bank. New cross-ties and guard rails have been put on all bridges, excepting Shoal Creek Bridge. Five new frogs were put in the side tracks at Locks 1, 5, and 6.

The miscellaneous work consisted in inspecting track and bridges, tightening bolts, making patterns for, casting, and putting down rail braces, repairing switches, loading and towing cross-ties, making new section posts and erecting same, making track gauge, and repairing track tools.

Rolling stock.—The construction of the inspection car was completed, and the derrick car was practically rebuilt, most of its timbers being decayed. Minor repairs were made to hand-car, three flat cars, observation, and laborers' cars. New pilots were built for the locomotives, and repairs made on their headlights.

Operating.—Two locomotives have been in use for the greater part of the year; they were engaged in towing boats and barges and transporting laborers and material.

TABLE E.—*Unit cost of operation and maintenance of railway.*

Month.	Last year.			This year.			Average, 2 years.		
	Cost per mile of track.	Miles run by locomotives.		Cost per mile of track.	Miles run by locomotives.		Cost per mile of track.	Miles run by locomotives.	
		Number.	Cost per engine mile.		Number.	Cost per engine mile.		Number.	Cost per engine mile.
July	.....	.....	.....	$62.11	1,754	$0.57	$62.11	1,754	$0.57
August	.....	.....	.....	78.52	1,854	.68	78.52	1,854	.68
September	.....	.....	.....	85.16	2,357	.58	86.16	2,357	.58
October	.....	.....	.....	62.00	2,119	.47	62.00	2,119	.47
November	$24.12	1,920	$0.18	30.35	1,860	.26	27.23	1,890	.22
December	11.70	1,588	.11	49.72	1,961	.40	30.71	1,784	.25
January	23.86	1,327	.26	63.86	2,086	.49	43.86	1,706	.38
February	24.14	1,298	.27	33.00	1,849	.28	28.57	1,573	.27
March	33.03	1,918	.25	45.19	2,209	.33	39.11	2,063	.29
April	38.03	2,182	.26	41.93	2,000	.33	39.98	2,091	.29
May	35.30	1,892	.28	26.56	1,866	.22	30.93	1,879	.25
June	35.83	1,754	.30	51.87	1,829	.45	43.85	1,792	.38
Average	28.25	1,735	.23	52.52	1,979	.42	47.75	1,905	.33

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MACHINE SHOPS.

The shops were described in the report of last year. During the present year there has been added a foundry containing a small cupola, having a capacity of from one-half to 1 ton per hour and capable of making a single casting weighing about 600 pounds.

A greater portion of the shop work is reported under the classification to which the work is chargeable; the work pertaining to the operation and repairs to the shops was as follows:

Erecting and lining cupola, making bolts, clamps, plates, and blast pipe for same; putting up blower for cupola and making brackets and bolts for same; repairing brass furnace, making tools, repairing boiler, engine, and lathe; making patterns and casting grate bars for shop boiler; making flasks for foundry; attending, oiling, and wiping machinery.

SAWMILL.

In order to minimize the cost and time of transferring lumber from the mill to the carpenter's shop, an addition has been built to the former, in which will be placed all of the wood-working machinery. An economy of power will also result, as the machine-shop engine will be relieved of the wood-working machinery, and the latter will be run by a turbine.

Miscellaneous work of mill.—Repairing mill machinery, planer, log carriage, belts and pulleys, making patterns and casting brackets and rollers, repairing planer gear; moving cut-off saw; repairing water wheel; moving, piling, and drying lumber.

TABLE F.—*Amount and cost of lumber sawed.*

Month.	Last year.				This year.				Average two years.			
	Sawed.		Planed.		Sawed.		Planed.		Sawed.		Planed.	
	Feet B. M.	Cost per 1,000 feet.	Feet B. M.	Cost per 1,000 feet.	Feet B. M.	Cost per 1,000 feet.	Feet B. M.	Cost per 1,000 feet.	Feet B. M.	Cost per 1,000 feet.	Feet B. M.	Cost per 1,000 feet.
July	44,227	$1.98	.....	.....	28,882	$1.40	35,713	$1.97	36,554	$1.69	35,713	$1.97
August	.....	.....	.....	.....	58,330	2.00	6,637	.95	58,330	2.00	6,637	.95
September	21,060	3.20	.....	.....	37,706	1.85	19,235	2.12	29,383	2.52	19,235	2.12
October	27,605	3.15	13,461	$1.78	31,862	2.22	16,860	2.37	29,733	2.68	15,160	2.07
November	30,959	2.56	11,184	1.55	18,261	2.12	30,524	2.04	24,610	2.34	20,854	1.79
December	34,898	2.78	23,708	1.52	48,363	1.92	19,647	1.76	41,628	2.35	21,677	1.64
January	41,284	2.12	2,827	1.89	42,975	2.10	12,200	2.25	42,129	2.11	7,513	2.07
February	34,165	1.73	8,935	2.70	29,706	1.57	25,584	2.52	31,935	1.65	17,259	2.61
March	39,936	1.82	16,842	2.09	21,583	2.18	17,422	2.20	30,759	1.50	17,132	2.14
April	33,941	1.88	27,794	1.08	18,710	2.15	14,760	3.14	26,325	2.01	21,277	2.11
May	20,468	3.11	24,359	1.60	9,397	2.35	22,218	3.00	14,932	2.73	23,288	2.86
June	29,758	2.35	23,995	1.72	8,337	2.26	8,939	3.36	19,048	2.30	16,467	2.04
Total	359,296	.....	153,105	.....	358,112	.....	229,739	.....	385,366	.....	222,212	.....

Average cost of logs per 1,000 feet, $5.80; average cost of loading and towing, $2; average cost of sawing, $2.01 per 1,000 feet; total cost of sawed lumber, $9.81 per 1,000 feet; average cost of planing, $2.31 per 1,000 feet; total cost of planed lumber, $12.12 per 1,000 feet.

BUILDINGS.

During the past year the following improvements have been made: Extension of foundry, sawmill, and ear shed; a new dry house, cow shed, and coal shed have been erected.

Statement of repairs.—Repaired skylight of machine shop, commissary building, foremen's quarters, lock masters' houses at Locks A and B; window blinds, sink, and floors of assistant engineer's quarters; pump house at Lock A; shingled roof of lock watchman's house at Lock 5; repaired mantel and grate at lock master's house at Lock 9. Painted and whitewashed interior of lock masters' houses at Locks A, B, 4, 5, 6, and 9. Painted exterior of lock watchmen's houses at Locks 1, 2, 3, 5, 7, 8, 9, A, and B; also lock masters' houses at Locks A and B, foremen's quarters, and property house.

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TABLE G.—*Unit cost of repairs and improvements to buildings.*

Month.	Cost per building last year.	Cost per building this year.	Average cost per building for two years.
July	$5.97	$9.36	$7.66
August	.....	7.93	7.93
September	5.05	4.79	4.92
October	.....	5.57	5.57
November	11.07	7.65	9.36
December	10.00	2.74	6.37
January	.77	4.58	2.67
February	.80	4.05	2.17
March	2.00	8.69	5.39
April	3.57	6.25	4.91
May	2.98	13.77	8.37
June	3.58	9.06	6.32
Total	45.29	84.44	71.64

FLOATING PLANT.

The following boats are used in connection with the operating and care of the canal:

1 steam flatboat.
1 naphtha launch.
6 deck barges.
1 Bucyrus dredge.
1 derrick boat.

STATEMENT OF REPAIRS.

Steam flatboat: Repairing machinery, wheel, hull, and sprocket chain; repainting.

Naphtha launch: Making patterns for and casting new eccentric strap, cleaning and repairing machinery, making new stem band, and painting hull.

Deck barges: Converting two coal barges into deck barges; calking and painting same; recalking, repairing, and painting barges.

Bucyrus dredge: Repairing hull, deck, lower tumblers, roller frame, and countershaft; put down new bedtimbers for pumping engines; straightening bucket ladder; whitewashed hull, put new roof on cabin, and repaired spud well.

Derrick boat: Painting, making bearings and flanges for engine.

DRY DOCK—OPERATING AND REPAIRS.

The following United States boats have been docked and repaired during the year: Steamers *Colbert*, *Lookout*, and *McPherson;* dredge boats *Bucyrus* and *Harwood;* 1 snag boat, 1 quarter boat, and four barges. Details of the repairs on the above boats may be found under the head of "Floating plant," and in the report of work done under the appropriation for general improvement of the Tennessee River.

Laid pipe from spring branch to dock for the purpose of testing the hulls of boats, graded the north and east banks so as to give a gradual approach to the dock, digging drains and ditches, cleaning and pumping water out of dock.

QUARTERS AND GROUNDS.

Locks A and B.—Grading and sowing grass; moving old barn; transplanting shade trees; repairing fences, gates, buildings, and steps; excavating stone and gravel, and refilling with earth.

Locks 2 and 3.—Building and painting new fences.

Lock 4.—Grading; planting grass and ivy; building spring house and steps in grounds.

Lock 5.—Repairing road and walks; building and painting steps and fence; planting ivy.

Lock 6.—Cleaning quarters and grounds; attending garden; building fences, coal house, hitching shed, stone culverts; repairing gates, roads, walks, and bridges; transplanting shade trees.

Lock 8.—Sowing grass.

MISCELLANEOUS.

Delays to boats.—The canal has been constantly open for traffic; no boats have been delayed, nor have there been any accidents.

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Subsistence.—The average cost of subsistence per man per month has been $6.27.
Forage.—The average cost of forage per animal per month has been $3.39.
Miscellaneous work.—Caring for Government animals, hauling and towing supplies; loading, towing, and unloading coal and logs, removing old dock at Lock 6, testing air drums, cutting derrick timbers, cutting wood and transferring lumber; making hammer, pick, and ax handles, staples for rafting logs, steam box, stepladder, hay rakes, cutter for wood worker, river gauge, spike poles, planer bits, screws, brackets, tables, chairs, wagon tongue, harness bench and cutter for wood worker; repaired lawn mowers, wood molding machine, boiler, air compressor, pulleys in carpenter shop, stone trucks, and cant hooks.

In towing supplies and making inspection trips the steam flatboat has run 2,392 miles during the year.

Very respectfully, your obedient servant,

SYDNEY B. WILLIAMSON,
Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

D D 3.

IMPROVEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

The French Broad River is one of the largest tributaries of the Tennessee. The stream has its source in North Carolina on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock, and after a course of 121 miles unites with the Holston River 4½ miles above Knoxville, thus forming the Tennessee River.

An appropriation was made by the State of Tennessee about 1840 for the purpose of improving the rivers of the section then known as the "East Tennessee District," and the improvement of Seven Islands Shoals of the French Broad River, about 30 miles below Dandridge, was begun under direction of commissioners appointed by that State. The State of Tennessee also built some dams above Dandridge, but these, with the exception of a few repaired by the United States in 1881, have been removed during the progress of the work under the present project.

An examination was made of the French Broad in Tennessee under authority of act of Congress July 11, 1870, and the report upon it is to be found in the Report of Chief of Engineers for 1871, pages 491–494. A reexamination in Tennessee was ordered by Congress in act of March 3, 1875, "from its junction with the Holston at Knoxville to Leadvale, Tenn." The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale, mouth of Nolichucky River, a distance of 90 miles, navigation is impeded by the surface obstructions usually found in mountain streams. This stretch of river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge about 50 miles. The fall being only about 1 foot per mile, the channel can be easily improved. From the junction of the Nolichucky River to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slack-water navigation, the fall being 7 feet per mile.

The present project of improving the channel from mouth of river to Leadvale, about 90 miles, consists in removing surface obstructions, cutting down overhanging trees, and building wing dams where necessary, so as to permit the passage of boats drawing 2½ feet during the ordinary low-water season. Under this plan operations have been carried on at the most serious obstructions.

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The following appropriations have been made by Congress for improving French Broad River in Tennessee, viz:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$10,000
March 3, 1881	3,500	July 13, 1892	15,000
August 2, 1882	5,000	August 18, 1894	7,000
July 5, 1884	3,500	June 3, 1896	5,000
August 5, 1886	6,000		
August 11, 1888	10,000	Total	75,000

The total amount expended to the close of the fiscal year ending June 30, 1897, including outstanding indebtedness, was $68,886.91.

This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish traps, constructing and modifying wing dams, and revetting the banks when necessary. A list of these ten obstructions, with their distances below Dandridge and the work done at each to June 30, 1890, is given in the Annual Report of the Chief of Engineers, 1891, pages 2262, 2263.

The improvements which yet remain to be made are generally of a class which can not be economically and advantageously executed without the possession of a very considerable plant. A towboat and barges are necessary to move stone for the construction of dams and the protection of banks. Derrick boats are necessary for the removal of snags and bowlders from the channel, and a drill raft with steam drills is needed for breaking up the reefs. Quarter boats are also necessary to conveniently take care of the laboring force. None of these things belong to the French Broad River, and the appropriations have always been too small to permit of their purchase.

No survey of the river has ever been made, and it is therefore very difficult to prepare detailed plans for its improvement. The total amount necessary to make the proposed improvement, which even at the time was not fully described, was simply a guess based upon a reconnaissance, and I am of the opinion that it will not be sufficient to complete all the work that must be done to carry out the improvement to the extent proposed.

The improvement of the French Broad River, Tennessee, is of importance to the inhabitants along its banks, not only by reason of its increasing commerce, but because of its being constantly used as a highway for travel by the people themselves, a large number of passengers being carried by the small steamers that ply upon this stream. The commerce consists principally of marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise. The completion of the existing project of improvement will materially aid in the development of the mines, and will open a river highway for the transportation of the mineral wealth of the mountains and the products of the rich agricultural lands of the region drained by the river and its tributaries.

In the latter part of July, 1897, the fleet belonging to the improvement of the Upper Tennessee River was sent to the French Broad and work was begun at Hanging Rock Shoals. The work here consisted in repairing the dam at the head of Brabsons Island, which had been breached, probably by persons who desired to form a passageway through it for small boats. The breach thus formed had been widened and deepened by high water and the action of drift and ice. Its effect was sufficient to materially reduce the depth of the water in the improved channel. About 1,000 cubic yards of broken stone was used in the repair of this dam. In addition to this, the bank at the lower end of the improved chute was protected by riprap, as it was found to be caving, in a way which would act injuriously upon the channel.

At Bryant Shoals, which is situated just below the mouth of the Little Pigeon, a large quantity of bowlders was found to have washed into the channel, having been brought out of the Little Pigeon in the time of freshets. These bowlders had lodged on the shoal where the river was wide and shallow, and greatly impeded navigation; 860 cubic yards of this loose rock was removed and was used in repairing the spur dams in the vicinity.

At Seven Island Shoals a good deal of work was done. This is really a series of shoals extending over several miles where the river is divided by the Seven Islands that give it its name; 1,700 cubic yards of loose stone and gravel was dredged from the channel through the shoals at various points, and the material was used in the protection of the bank and the repair of existing dams.

At a place in the shoals known as the Red Bank the bank of the river was caving rapidly, so as to form a deep pocket, giving injurious currents and inducing the formation of a bar. To correct this, the bank was protected by a timber crib filled with stone and having a length of 728 feet. In addition to the stone obtained from the river, 660 cubic yards was quarried from the bank, for the repair and extension of the dikes.

At Greens Reef a channel 100 feet wide was blasted through the reefs and the stone was used in the construction of a spur dike; 750 cubic yards of solid rock was excavated.

In addition to this, work was done at Huffakers Shoals, Johnsons Shoals, Cement Shoals, Bowmans Shoals, Humes Shoals, Pennyroyal Shoals, and Hines Creek Shoals; at each of these places the work consisted in the removal of loose rock and gravel from the channel, the material being used to strengthen the dikes and dams or to revet the bank where necessary; 1,235 cubic yards of material in all was excavated at these latter places.

LITTLE PIGEON RIVER, TENNESSEE.

This stream is formed by the junction of its east and south forks at Sevierville, Tenn., and flowing northwesterly for about 5 miles it enters the French Broad River about 32 miles above Knoxville.

An examination of Little Pigeon River was made under the provisions of river and harbor act of September 19, 1890. The channel was found to be obstructed by rock reefs and gravel shoals, the object of the proposed improvement at the estimate of cost submitted ($10,000) being to open up the river to navigation as far as Catlettsburg, about 2 miles, permitting the passage of the small steamers that ply upon the French Broad River, and occasionally during extreme high water to ascend to Sevierville, 5 miles from the mouth of the river. (See report printed as House Ex. Doc. No. 159, Fifty-first Congress, second session, and Report of Chief of Engineers, 1891, pp. 2287–2288.)

The river and harbor act of July 13, 1892, provided that of the $15,000 appropriated for improving French Broad River, Tennessee, $1,000 "may be used in removing bar or shoal in Little Pigeon River." This sum was allotted for the removal of the bar near the mouth of the river, described as the only bad shoal below Catlettsburg.

The total amount expended to close of fiscal year ending June 30, 1897, was $1,150.39.

About the middle of August, 1897, a portion of the fleet employed in improving the French Broad River was sent to work at the mouth of the Little Pigeon. The work was confined to the bar at the mouth of the river, where a large quantity of sand, gravel, and bowlders are annu-

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ally deposited by the freshets, thus forming a very troublesome bar and preventing steamboats from entering the Little Pigeon when the rivers fall. A channel 30 inches deep and of sufficient width was dredged through this bar.

The Little Pigeon discharges into the French Broad just above a long island called McCroskeys Island. The navigable channel of the French Broad is upon the right-hand side of this island, and in the improvement of the mouth of the Little Pigeon a dam has been built across the head of the left-hand chute. The head of the island was found to be washing away, and to protect this and preserve existing conditions, which were favorable, the head of the island was thoroughly riprapped. Some material was also used in strengthening a dam across the slough; about 1,500 cubic yards was dredged from the bar, and about 1,000 cubic yards of the loose rock thus obtained was used in riprapping the island and the remainder upon the dam.

For a detailed account of the improvement of the French Broad and Little Pigeon rivers I would respectfully invite attention to the report of Superintendent R. R. Thacher, which is transmitted herewith.

Money statement.

July 1, 1897, balance unexpended	$6,244.32
June 30, 1898, amount expended during fiscal year	5,848.62
July 1, 1898, balance unexpended	395.70
July 1, 1898, outstanding liabilities	131.23
July 1, 1898, balance available	264.47
Amount (estimated) required for completion of existing project	85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	38,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Commercial statistics of French Broad River, Tennessee.

Articles.	Year ending December 31—				Estimated value, 1897.
	1894.	1895.	1896.	1897.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Grain	28,933	9,814	17,780	7,174	$120,980.80
Lumber	5,733	7,414	16,260	6,850	51,375.00
Flour	733	506	5,028	65	3,575.00
Live stock	458	480	4,000	374	23,375.00
Wood	.....	400	12,150	1,100	1,100.00
General merchandise	13,546	10,311	3,060	1,055	95,100.00
Iron ore	.....	66	.....	.....	.....
Hoop poles	.....	12	2,900	300	2,025.00
Coal	.....	566	2,000	200	400.00
Hay	.....	1,500	3,750	295	4,720.00
Logs	.....	7,041	83,838	24,513	122,565.00
Shingles	.....	5,000	30	95	1,900.00
Brick	.....	133	1,063	235	940.00
Sand	.....	.....	77,400	10,000	6,700.00
Tan bark	.....	.....	2,000	.....	.....
Railroad ties	.....	.....	2,920	.....	.....
Tobacco	.....	.....	225	.....	.....
Fertilizer	.....	.....	500	.....	.....
Produce	.....	.....	800	.....	.....
Marble	.....	.....	12,000	18,000	180,000.00
Telephone poles	.....	.....	1,500	.....	.....
Stone	.....	.....	.....	500	2,500.00
Total	49,398	42,898	249,204	70,756	617,255.80

Number of passengers transported (1897), 3,020.

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List of steamboats (stern-wheel) plying on the French Broad River, Tennessee.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
G. M. Fouche and 15 barges	93	14	2	61.12	300
Flora Swan and 7 barges	98	13	2.8	57.81	280
Onega and 3 barges	104.8	18	2.5	69.79	120
Lucile Borden and 2 barges	86	14	2.5	45.74	80
Telephone and 15 barges	93	19	2.6	97.47	450
1 barge					20

In all, 5 steamboats of 331.93 tons burden net and 43 barges of 1,250 tons capacity.

REPORTS OF MR. R. R. THACHER, SUPERINTENDENT

KNOXVILLE, TENN., *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operations on the French Broad River for the fiscal year ending June 30, 1898:

At the ending of the last fiscal year the fleet was lying at Knoxville, waiting for a low stage of water, so that the old bridge piers that were put in the river during the civil war by General Burnside could be removed. Owing to continued high water for that season of the year the project for their removal was abandoned until later.

On July 21 the fleet was taken in tow by the U. S. steamer *Long* and proceeded up the French Broad River, where work was begun at Hanging Rock on the 23d, and Seven Island Shoals on the 26th of July.

The work at Hanging Rock Shoals consisted of repairing break in the dam at the head of Brabsons Island. This break was made by some unknown persons, who evidently tore out enough rock to allow the passage of a skiff, and thereby weakened the dam; then high water and drift enlarged the break to such an extent that it caused the channel opposite to become shallow. This break was closed and the dam at that point was reenforced. The work then was confined to the foot of the shoals, riprapping bank, building lower end of retaining dam, and reenforcing check dams.

	Cubic yards.
Earth stripped in quarry	110
Stone quarried, riprap	2,140
Riprap used on bank	1,050
Riprap used in dams	940

On August 14 the fleet that was at work at Hanging Rock was divided; part was dropped down to Seven Islands, the other was towed by the U. S. steamer *Long* to Bryants Shoals. The working party at Bryants Shoals was engaged in excavating bowlders from the channel and utilizing them in riprapping dams at that place. Great quantities of bowlders are washed out of Little Pigeon River, which empties into the French Broad at the head of Bryants Shoals; these lodge on the shoals and impede navigation so that from time to time they have to be removed to give the necessary depth in channel.

BRYANTS SHOALS.

	Cubic yards.
Loose rock excavated from channel	860
Dams repaired	860

The following places are included in Seven Island Shoals, where work was carried on: Wesley Chute, Tuckahoe Chute, Red Bank, Foot of Shoals, and Greens Reef.

WESLEY CHUTE.

The channel was dredged, to a depth of 3 feet, of bowlders, sand, and gravel and the same placed on dam. The old abandoned retaining dam was removed and the stone placed on the retaining dam now in use.

	Cubic yards.
Bowlders and gravel excavated from channel	405
Old dam removed	775
Dam repaired	1,180

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TUCKAHOE CHUTE.

The channel at Tuckahoe Chute was cleared of loose rock and the trees that obstructed the channel were cut down.

Loose rock excavated from channel	Cubic yards	135
Dam repaired	do	135
Trees cut	Number	45

RED BANK.

The water had undermined the bank at this place, and high water caused it to cave in. The material washed down and formed a troublesome bar. To remedy it a crib was built, 728 feet long and 4 feet 8 inches high, of white oak, 8 by 8 inches by 12 and 14 feet long, to act as a retaining wall. The crib was sheeted with 1 by 12 inch oak and filled with the loose rock and gravel excavated from the channel.

Crib built 728 feet long, 4 feet 8 inches high, 8 by 8 inch white oak 12 and 14 feet long; total feet B. M., 34,138.

Loose rock and gravel excavated from channel and put in crib, 385 cubic yards.

Earth for foundation of crib, 210 cubic yards.

The bank behind the crib was given a natural slope.

FOOT OF ISLANDS.

From the Red Bank down to Greens Reef the channel was excavated of loose rock and the rock utilized in the repair of check dams. At the foot of the lower island a retaining dam 188 feet long was built to prevent the water at that point from spreading.

	Cubic yards.
Earth stripped from quarry	811
Stone quarried for dams	660
Quarried stone used in dam	250
Dams repaired	1,855
Dam built	1,880

GREENS REEF.

A channel 100 feet wide was blasted through the reefs and the stone used in building a check dam 250 feet long just below the reefs from the left bank, to straighten the current and back water over the excavated channel.

	Cubic yards.
Solid rock blasted from channel	750
Dam built	750

As the funds for the French Broad River were nearly exhausted it was deemed advisable to reduce the force. On September 18 the larger portion of the fleet was sent to the Tennessee River. The small party left on the French Broad River worked their way downstream, stopping at the following places:

	Cubic yards.
Huffakers Shoals:	
Loose rock excavated from channel	340
Bank riprapped	340
Johnsons Shoals:	
Loose rock excavated from channel	100
Bank riprapped	100
Cement Shoals:	
Loose rock excavated from channel	165
Bank riprapped	135
Dam repaired	30
Bowmans Shoals:	
Loose rock excavated from channel	270
Dam repaired	270
Humes Shoals:	
Loose rock excavated from channel	155
Bank riprapped	155
Pennyroyal Shoals:	
Loose rock excavated from channel	55
Dam repaired	55
Hines Creek Shoals:	
Loose rock excavated from channel	170
Bank riprapped	170

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On November 4 the fleet and working party reached Knoxville and joined the Tennessee River fleet at work there.

Very respectfully, your obedient servant,

R. R. THACHER, *Superintendent.*

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

KNOXVILLE, TENN., *June 30, 1898.*

MAJOR: I have the honor to submit the following report of operations on the Little Pigeon River for the fiscal year ending June 30, 1898:

Work was commenced August 14 by a working party and confined to the bar at the mouth, as large quantities of sand, gravel, and bowlders are annually washed out of that river and are deposited at the mouth, making a very troublesome bar.

A channel 30 inches deep was dredged through the bar. The material was used in riprapping the head of McCroskeys Island and to repair the dam in the slough.

	Cubic yards.
Loose rock removed	1,605
Riprapping island	1,075
Repairing dam	430

Fleet and working party left the Pigeon River and joined the working party at work at Seven Islands on September 18.

Very respectfully, your obedient servant,

R. R. THACHER, *Superintendent.*

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

D D 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE AND VIRGINIA.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga and 79 miles below Knoxville, the length of its course in Tennessee being about 230 miles.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river, about 4,500 square miles, is mountainous and has very meager transportation facilities.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. Osborn Ford, Virginia, about 35 miles northeast of the Tennessee line, is regarded as the head of high-water navigation on the Clinch River. It has no low-water navigation. (See Report of Chief of Engineers, 1876, pp. 736–747.) An examination of the Clinch River fron Nash Ford, Virginia, to Haynes (or Walkers Ferry), Tenn., a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1864–1867.) The original project, submitted in 1876, provided only "to improve the high-water navigation of this river, so that there shall be less difficulty and danger in bringing out cargoes, and so that rain tides of 3 or 4 feet may be made use of for boating purposes." This was estimated at $26,400. In 1881 the engineer officer in charge reported that he hoped to attain a permanent increase of depth of water in channel by blasting rock, etc., "securing for about 146 miles of the lower river at ordinary low water, from its mouth to Clinton, about 2

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feet, and from Clinton to Walkers Ferry (Haynes) about 1½ feet," adopting the low-water channel, which in 1876 had been simply suggested as a channel that might be found practicable after a careful survey, and thus modifying the then existing project, but without increasing the original estimate, which was simply for high-water navigation, by the cost of the channel projected. In 1885 the estimate was increased to $50,000, "because it had been found necessary to make the channel from two to three times the width thought sufficient when the original estimates were made," but the estimate was not increased, although it was proposed to secure a low-water navigation instead of a navigation limited to high and intermediate stages, as was originally contemplated in the projects upon which the estimates were made. The balance of the estimate now remaining unappropriated being $8,500 in all, is therefore manifestly insufficient to complete the work proposed.

The examinations of the Clinch River which have been made up to the present time are really not sufficient upon which to base a reasonable estimate of the actual cost of the proposed low-water channel below Walkers Ferry, but before this improvement is really undertaken it will be proper and necessary to make a detailed survey, in order to determine the actual cost of what can be done to carry out the work advantageously and with due economy.

From Walkers Ferry up to Osborne Ford, Virginia, 120 miles, the only improvement contemplated is to reduce the ledges and remove the loose rock, snags, and overhanging trees obstructing the channel to such an extent as to enable flatboat navigation and rafting to be carried on safely at the high and intermediate stages.

The following appropriations have been made for this improvement:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$4,000
March 3, 1881	3,000	July 13, 1892	4,000
August 2, 1882	3,000	August 18, 1894	2,500
July 5, 1884	5,000		
August 5, 1886	5,000	Total	41,500
August 11, 1888	5,000		

The total amount expended to June 30, 1897, including outstanding indebtedness, was $37,182.04. The general results attained by this expenditure are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun.

The low-water navigation of the Clinch River amounts to nothing under the present conditions. It can not be carried on to an extent sufficient to have any practical value. All the business that is done upon the river is at high or intermediate stages. The principal commodity consists of logs made up into rafts, and this rafting business is a large and increasing industry. There yet remains a very large area of fine oak timber, for which there is a growing demand at the cities lower down on the Tennessee River. Any work, therefore, which may be done which will facilitate the operation of rafting on the river or lengthen the season of navigation for rafts, by permitting them to be floated with safety at lower stages, will be of immediate value to commerce and perhaps the greatest value that can be secured at moderate expense.

Early in July, 1897, a working party was assembled at Osborne Ford Virginia, at the head of navigation. This party was provided with tools, explosives, camping equipage, and provisions, and having constructed 10 rough light-draft bateaux, descended the river to where it

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unites with the Tennessee, at Kingston. In passing down the river the party removed, as far as practicable, the obstructions to navigation at stages at which the river is ordinarily used. These obstructions consisted generally of bowlders, rock reefs, gravel bars, snags, and overhanging trees. With the party there was a raft pilot who had had extensive experience in the navigation of the river and was thoroughly familiar with the obstructions which most interfered with navigation.

The general method of operation was as follows:

When the obstruction consisted of gravel bars and shoals the men were put into the water and the material was either thrown into deep holes or loaded into boats and taken to the shore, or to some pool in which it could be deposited.

Everything in the main channel calculated to interfere with the safe passage of boats or rafts was removed. When the obstructions consisted of ledges of solid rock, or bowlders too large to be handled, they were drilled and blasted and the pieces disposed of as before. In a great many cases it was possible to blow the ledges and bowlders directly into deep water, so that no handling was necessary, and this rendered work of this character very cheap, so that it cost no more than the handling of small stone. Leaning trees and snags were either blown up by explosives or cut to pieces and so disposed of that they could not again become obstructions to navigation.

The party reached Kingston on the 10th of October, where the outfit was stored and the party disbanded. In passing over the river, work was done at more than sixty different localities. In the aggregate, 6,547 cubic yards of ledges and bowlders requiring blasting were disposed of; 4,602 cubic yards of gravel and small stone was removed from the channel; 299 trees were cut, and 703 snags removed. The total cost of the field work was less than $3,000.

The result of this work has been very gratifying to those who use the river. It is stated by competent raft pilots that they can come out with their rafts upon a foot less water than formerly, and that at all times navigation is easier and safer, and that the rafts can be handled with smaller crews. Further work of this character is very desirable.

For the names of the localities at which the work was done and the kind and extent of improvement at each place, I would respectfully invite attention to the report of Master Laborer E. R. Nelles, who was in charge of the work during the season.

Money statement.

July 1, 1897, balance unexpended	$4,346.80
June 30, 1898, amount expended during fiscal year	2,927.98
July 1, 1898, balance unexpended	1,418.82
July 1, 1898, outstanding liabilities	28.84
July 1, 1898, balance available	1,389.98
Amount (estimated) required for completion of existing project	8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	8,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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Commercial statistics of Clinch River, Tennessee.

Articles.	Year ending December 31—				Estimated value, 1897.
	1894.	1895.	1896.	1897.	
	Tons.	Tons.	Tons.	Tons.	
Grain	1,290	1,276	5,152	13,061	$220,414.85
Flour	110	71	95	240	13,200.00
Iron ore	44	766	.....	28,210	33,852.00
Lumber	201	1,844	2,376	5,026	37,695.00
Live stock	80	1	32	200	12,500.00
General merchandise	11,207	840	1,386	3,550	311,655.62
Logs	.....	61,473	23,860	41,884	209,142.50
Cotton	.....	13	.....	.....	.....
Coal	.....	466	2,800	1,371	2,742.00
Hay	.....	2,150	665	1,011	16,176.00
Brick	.....	.....	170	85	340.00
Staves	.....	.....	50	.....	.....
Tan bark	.....	.....	40	.....	.....
Railroad ties	.....	.....	1,485	35	87.50
Produce	.....	.....	145	218	13,111.00
Sand	.....	.....	1,200	1,997	1,337.99
Stone	.....	.....	.....	5,655	28,275.00
Fertilizer	.....	.....	.....	66	2,709.00
Total	12,932	68,900	39,456	102,629	903,238.46

Number of passengers transported (1897), 3,017.

List of steamboats (stern-wheel) plying on the Clinch River, Tennessee.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	Feet.	Feet.		Tons.
E. P. Dawson and 4 barges	90	10	2.8	29.30	124
Kingston and 4 barges	55	11	2.6	37.80	100
Key City and 3 barges	80	15	3.1	59.45	150
Maud and 4 barges	79	16.5	3.2	23.30	900
Spring Hill and 9 barges	135	26.6	4	156.33	3,600
J. C. Warner and 1 barge	142	31.6	4.6	201.05	70
J. P. Kindrick and 1 barge	112	20	3.7	128.71	80
Clinton B. Fiske and 2 barges	100	18	3.4	79.89	80

In all, 8 steamboats of 715.83 tons burden net and 28 barges of 5,104 tons capacity.

REPORT OF MR. E. R. NELLES, MASTER LABORER.

RIVERTON, ALA., *December 27, 1897.*

MAJOR: I have the honor to submit the following report on the work of removing obstructions from the Clinch River in Virginia and Tennessee:

Under your orders, Mr. J. H. Catron and myself proceeded to St. Paul, Wise County, Va., early in July, 1897, for the purpose of organizing a party and constructing the necessary boats for the work.

The river, except during rain tides, is narrow, crooked, and full of rapids and shoals. Consequently, it was necessary to use light boats that could be handled in shoal water or, when necessary, carried around the shoal places.

The fleet constructed consisted of 7 bateaux 2 feet to 2 feet 6 inches wide by 15 inches deep by 16 feet long; 2 boats 4 feet wide by 15 inches deep by 16 feet long; 1 boat 6 feet wide by 14 inches deep by 18 feet long.

The larger boats were used for carrying the camp outfit, tools, and supplies, and the bateaux for carrying the men and for handling the small bowlders, gravel, etc., taken from the channel.

Some delay was occasioned by the nonarrival of the tents and supplies.

On July 22 the organization was completed, and the party started for Osbornes Ford, the head of navigation in the Clinch River.

As before stated, the river is narrow, crooked, and full of shoals and rapids, and it is used almost entirely for rafting out logs during the so-called "rain tides." The obstructions, aside from those above mentioned, consist of overhanging trees, snags,

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rocky ledges, and points running out into the streams, milldams, fish dams, and large bowlders scattered along the shore and on the shoals.

With Mr. Catron, who is an experienced raft pilot and familiar with the needs of this business, was left the question of deciding to what extent it was necessary to reduce or remove these obstructions, so as to produce a practically uniform condition and make rafting possible on smaller tides than heretofore. It is believed that the work done will enable raftsmen to run the river on at least a foot less water than ever before.

The general method of operation was as follows:

When the obstruction consisted of gravel bars and shoals, the men were put into the water and the material either thrown into deep water or loaded into the bateaux and taken to the shore or to the nearest deep pool. Everything in the main channel calculated to in any way interfere with the safe passage of rafts was removed.

When the obstruction consisted of ledges of solid rock or rock bowlders they were drilled and blasted to pieces, and the material disposed of by throwing it into the pools or carrying it to the shore. In a great many cases it was possible to blow the ledges or bowlders directly into deep water without any handling. This greatly reduced the cost of the rock work, and accounts for the fact that the rock work cost practically the same per cubic yard as the gravel and small bowlders.

The leaning trees and snags were either blown up with dynamite or cut up by hand, and so disposed of as not to form future obstructions.

Actual operations were commenced on July 26, at Buster Shoals, 1 mile below Osbornes Ford. Between this point and the Auger, a distance of about 45 miles, the work consisted mainly in the removal of snags, gravel shoals and a number of fish-trap dams.

At the Auger, which is a sharp, rocky point extending out into the river, the first heavy rockwork was done. The river makes a very sharp turn around this point, and by its removal it is thought that a very decided improvement was effected.

At Rogers Shoals, immediately below the Auger, a large quantity of rock, as well as small bowlders and gravel, was removed.

One of the worst obstructions in the river is the Lawson milldam, 236 miles above Kingston. An opening was made in this dam for the passage of our outfit, and, notwithstanding great care in getting the boats through, two were sunk and a number of valuable tools and supplies were lost. The following day, on demand of the owner, we returned and repaired the break in the dam. This matter was specially and fully reported to you in September, 1897.

The Thirty-Mile Shoals form the next series of obstructions. About three weeks were spent on this section of the river, and a very large quantity of gravel, bowlders, ledges, and solid rock was removed.

At Hobsons Shoals and Sheltons Cliff a large number of bowlders were removed from the center of the river, as well as from the banks.

From Sheltons Cliff to the mouth of the Powell River, a distance of nearly 100 miles, very little work was done—only about a week being necessary to cover this distance.

After passing Clinton no extensive work was found necessary except at Blacks Island Bluff, Freels Bluff, Freels Shoals, Taylor Island, and Polecat Eddy. At each of the above points considerable blasting was done and more or less gravel removed.

Kingston was reached on October 10, where the outfit was stored and the party disbanded.

The following table gives the location, nature, and amount of the obstructions removed:

Location and nature of obstructions removed.	Above Kingston.	Trees cut.	Snags removed.	Small bowlders and gravel removed.	Large bowlders and ledges blasted.
	Miles.			*Cu. yds.*	*Cu. yds.*
Osbornes Ford	312				
Buster Shoals				188	
Pennington fish-trap dam				11	
Somonus Island fish-trap dam				25	
1 mile below island, fish-trap dam				28	
1 mile below island, shoals				11	
Mouth of Stony Creek, shoals				182	
Mouth of Stony Creek, right bank			11		
Pennington Island, shoals				12	
8 miles below island, fish-trap dam				15	
1 mile below Crafts Mill, fish-trap dam				87	
1 mile below Crafts Mill, left bank					88
On towhead, 200 feet below Crafts Mill			290		
Craft's milldam				7.10	
1 mile below Crafts Mill, shoals				9.70	

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Location and nature of obstructions removed.	Above Kingston.	Trees cut.	Snags removed.	Small bowlders and gravel removed.	Large bowlders and ledges blasted.
	Miles.			*Cu. yds.*	*Cu. yds.*
1 mile below Crafts Mill, left bank			7		
1½ miles below Clinchport Shoals	286			40	
1½ miles below Clinchport Shoals, right bank					14.80
2½ miles below Clinchport, left bank					27
1 mile below Speers Ferry, left bank			100		
Do					49.20
1 mile below Speers Ferry, fish-trap dam				37	
Neeleys Shoals				17	
Neeleys Ford, left bank					43
Neeleys Ford, right bank					89
Church Ferry, right bank					8.80
Auger, right bank	267				116.60
On bank opposite Auger				377.40	190.50
On bank, Auger				215.20	
Tignor Shoals, 1 mile above Auger, fish-trap dam				74	
On point above Auger, right bank					1.40
On point above Auger, left bank					238.20
Tignor Shoals, left bank					195.90
¼ mile below Auger, left bank			35	158.60	180.90
Rogers Shoals, left bank	266			201.90	
Rogers Shoals, right bank					931.50
¼ mile below Kyles Ford Lewis fish-trap dam				9.50	
6 miles below Rogers Shoals, Bakers fish-trap dam				74	
9 miles below Rogers Shoals, Frosts fish-trap dam				74	
Lawsons milldam, head of Thirty-Mile Shoals	234				173.90
McDaniels Shoals, left bank					203.20
Grissom Island, upper end, left bank					168.80
Grissom Island, lower end, right bank					100.40
Johnson Shoals, left bank					192.80
Johnson Shoals, fish-trap dam				111.10	
T. Collins Bend, right bank					97.80
T. Collins Bend, 3 fish-trap dams				401	
Poseys Shoals, left bank					277.80
Poseys Shoals, fish-trap dam				37	
Upper Joe Mills Bend, right bank					220.90
Lower Joe Mills Bend, left bank					41.70
Lower Joe Mills Bend, fish-trap dam				44.40	
Lower Joe Mills Bend, shoals, left bank					80.50
¼ mile above Kincades Ferry, right bank					40.30
¼ mile below Kincades Ferry, right bank					58.20
1 mile below Kincades Ferry, right bank					11.40
1 mile below Kincades Ferry, left bank					8.50
Evans Old Bridge Pier				200	
Evans Old Pillow, fish-trap dam				37	
Evans Old Pillow, fish-trap dam				355.50	
Evans Old Pillow, sledging ledges				40	
1 mile below Pillow, fish-trap dam				74	
1 mile below Pillow Shoals				155.50	
Basin Hole, left bank					80.70
Basin Hole, right bank					70.10
Gouge Hole, left back					147.80
Foot of Thirty-Mile Shoals	204				
M. V. Bunch, fish-trap dam				257.40	
Hobsons Shoals, left bank					97.50
Hobsons Shoals, center river					322.80
Sheltons Cliff, sledged				59	
Sheltons Cliff, fish-trap dam				73.80	
Sheltons Cliff, right bank				55	328.70
Sheltons Ford, right bank	190				44.10
K. C. G. and L. Rwy. Bridge, right bank	183			42.90	
Hunters Shoals, right bank					72.60
Hunters Shoals, left bank					49.60
Hunters Shoals, fish-trap dam				333.30	
Evans fish-trap dam				88.80	
Cut-off Island, left bank	150		4		
Kellers Bluff, right bank			9		12.20
Kellers Bluff				111.10	
Bear Hole Shoals, left bank					17.70
Head of Gourd Island, left bank	135		10		
Hibbs Island, right bank					47.30
Powell River	97				
Clinton, Tenn	70				
4 miles below Clinton, right bank			8		
6 miles below Clinton, center river			6		
7 miles below Clinton, left bank			4		
9 miles below Clinton, right bank			2		
Blacks Island Bluff, right bank	52				197
Blacks Island Bend, right bank			6		
Blacks Island Bend, right chute			18		
Lower end Blacks Island, center chute			3		

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Location and nature of obstructions removed.	Above Kingston.	Trees cut.	Snags removed.	Small bowlders and gravel removed.	Large bowlders and ledges blasted.
	Miles.			*Cu. yds.*	*Cu. yds.*
Cobbs Ferry, right bank			3		
¼ mile above Freels Bluff, left bank			5		
Freels Bluff, right bank	45		2		166.10
Freels Bluff, left bank			5		
Johnsons Ferry, right bank			1		
¾ mile below Freels Bluff, left bank			7		
¼ mile below Freels Bluff towhead, left bank			32		
¼ mile above Freels Island, left bank					88.90
Freels Shoals, left bank, fish-trap dam				148.10	263.20
2¼ miles below Freels Bluff, left bank			2		
¼ mile above Taylors Island, right bank			1		
Head of Taylors Island, left bank	35		4		
Lower end Taylors Island, left bank			3		
Opposite lower end Taylor's Island, left bank					309.50
Taylors Island, fish-trap dam				162.90	
Taylors Island, right bank			17		
Black Oak Shoals, left bank			3		
Goodman Shoals, left bank	25		12	10	11.60
Blue Springs Landing, right bank		73	8		
¼ mile below landing, right bank			5		
¼ mile above Jones Island, right bank			4		
¼ mile above Pickels Island, right bank			7		
¼ mile above Poplar Creek Bluff, right bank		38	14		
¾ mile below Poplar Creek Bluff, right bank			6		
¾ mile below Poplar Creek Bluff, right bank		3			
Opposite Poplar Creek Island, right bank	16	84	8		
Poplar Creek Island, right bank					11.10
Jones Island, right chute		2	11		
Jones Island, left chute			5		
¼ mile above Ring-top Shoals, left bank		1			40
Ring-top Shoals, right bank			11		
Lower end Ring-top Shoals, right bank			4		
Upper end Polecat Eddy, right bank			3		
Polecat Eddy, left bank		60			287.30
¼ mile above eddy, left bank		38			
Lower end of Polecat Eddy, left bank	8		2		
¼ mile above Emory River, left bank			3		
¼ mile above Emory River	5				80
¾ mile below Emory River			2		
Kingston					
Total		299	703	4,602.60	6,546.80

The detailed cost of the work was as follows:

6,547 cubic yards large bowlders and ledges, requiring blasting	$942.36
4,602 cubic yards gravel and small bowlders	704.22
299 small trees cut	13.17
703 snags removed	111.57
Moving camp	329.91
Cost of boats	51.44
Tools, etc., stored at Kingston	246.13
Subsistence, 5,353 meals, at 7 cents	400.20
Total	2,799.00

Distributing the cost of moving camp, subsistence, boats, tools, etc., gives the following unit costs:

6,547 cubic yards rock, requiring blasting, at 22½ cents	$1,457.36
4,602 cubic yards bowlders, etc., at 23 cents	1,064.22
299 small trees cut, at 21 cents	63.17
703 snags removed, at 30 cents	214.25
Total	2,799.00

Very respectfully, your obedient servant,

E. R. NELLES, *Master Laborer.*

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

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APPENDIX E E.

IMPROVEMENT OF FALLS OF THE OHIO RIVER, OF WABASH RIVER, INDIANA AND ILLINOIS, OF WHITE RIVER, INDIANA, AND OF CERTAIN RIVERS IN KENTUCKY.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio River at Louisville, Kentucky.
2. Operating and care of Louisville and Portland Canal, Kentucky.
3. Wabash River, Indiana and Illinois.
4. Operating and care of lock and dam at Grand Rapids, Wabash River.
5. White River, Indiana.
6. Tradewater River, Kentucky.
7. Lock No. 2, Green River, at Rumsey, Kentucky.
8. Green River, above mouth of Big Barren River, Kentucky.
9. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
10. Rough River, Kentucky.
11. Operating and care of lock and dam on Rough River, Kentucky.
12. Kentucky River, Kentucky.
13. Operating and care of locks and dams on Kentucky River, Kentucky.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 18, 1898.

GENERAL: I have the honor to transmit herewith annual reports for the works under my charge at the close of the fiscal year ending June 30, 1898.

* * * * * * *

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF FALLS OF OHIO RIVER AT LOUISVILLE, KENTUCKY.

For full report of project see pages 2221 and 2224, Report of the Chief of Engineers, United States Army, for fiscal year ending June 30, 1896.

Operations during the year consisted of the completion of the retaining wall at the westerly end of the enlargement, and revetment

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of the slope behind it; the continuation of drilling, blasting, and excavating to grade of material south of the new north wall. This work was continued throughout the year, excepting when the stage of water and weather conditions would not permit.

The guiding dike and the break in the cross dam between the Middle and Indiana chutes were repaired.

During the month of September the Indiana Chute, opening in the cross dam, was closed by temporary cribs to divert the water into other spillways and expose the rock to be excavated from the channel below the dam, thus facilitating the work of drilling and excavating, as well as affording an opportunity for making satisfactory cross sections of area within the limits of improvement. These cross sections showed that the amount of excavation had been underestimated, which is not surprising considering the fact that previous measurements were made in swiftly running broken water. We have now an accurate knowledge of what has been done and what remains to be done, and in addition will be enabled to dispel the cloud of mystery which has for years made the Indiana Chute a terror to steamboat men.

I have included drawings of the compressor boats, constructed last season, for prosecuting the work of drilling rock at the head of the canal. This work has hitherto been done by the use of steam, the boilers set up on the rock at low water, and, being necessarily removed at each rise of the river, a source of expensive delay. With the present plant the work can be prosecuted at any stage of water less than 12 feet. The drills are, at low stages, set on the rock and connected with the compressed-air supply on the barge by a suitable arrangement of pipes; at higher stages the drills are worked from the barge itself, as shown in the accompanying photograph. The advantage of this plant is, I think, apparent, and the substitution of compressed air for steam gives an increase of efficiency to the drills of about 25 per cent.

Work on this section was prosecuted vigorously until November 9, 1897, when the river rose rapidly, submerged part of the temporary dam, flooded the channel below, and necessitated the suspension of operations for the season.

At Willow Point the construction of the stone dike west of that point was resumed September 24, 1897, and continued to November 9, 1897, and suspended until June 9, 1898, on which latter date preparations for work during the present season were commenced.

The details of work done at the several points where operations were in progress are set forth in the accompanying reports of Assistant Engineers J. H. Casey and G. W. Shaw, who have had immediate supervision of the work. I desire especially to commend the services of these gentlemen, to whose energy and ability are due the measure of success attained.

The sundry civil act of July 1, 1898, contains the following item:

Improving Falls of Ohio River at Louisville, Kentucky: For completing improvement, including Indiana Chute Falls, one hundred and sixty-seven thousand two hundred and fifty dollars, of which sum fifteen thousand dollars shall be used for restoring the levee and banks of the Ohio River at or near Shawneetown, Illinois, recently swept away by the high waters in said river, such sum to be immediately available.

From the above it will be seen only $152,250 of the amount appropriated is applicable to the "Falls" projects, and that $15,000 of the estimated cost of work under those projects have been diverted by law to other purposes; therefore this latter amount is continued in the estimate of amount required to complete.

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Money statement.

July 1, 1897, balance unexpended	$359,236.16
Amount appropriated by sundry civil act approved July 1, 1898	152,250.00
	511,486.16
June 30, 1898, amount expended during fiscal year	113,056.79
July 1, 1898, balance unexpended	398,429.37
July 1, 1898, outstanding liabilities	11,905.36
July 1, 1898, balance available	386,524.01
Amount (estimated) required for completion of existing project	89,697.60
Amount that can be profitably expended in fiscal year ending June 30, 1900	89,697.60
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Allotments for Indiana Chute from appropriations for improving Ohio River.

July 14, 1880	$10,000
March 3, 1881	50,000
August 2, 1882	35,000
July 5, 1884	10,000
August 5, 1886	20,000
August 11, 1888	15,000
Total	140,000

Appropriations for work on Indiana Chute.

September 19, 1890	$25,000
July 13, 1892	35,000
August 18, 1894	20,000
Total	80,000

Appropriations for improving Falls of Ohio River at Louisville, Ky. (Enlargement at head of canal and of basin at locks).

July 5, 1884	$300,000
August 5, 1886	150,000
August 11, 1888	150,000
September 19, 1890	60,000
July 13, 1892	60,000
August 18, 1894	60,000
Total	780,000

Appropriations for improving the Falls of Ohio River and Indiana Chute Falls, Ohio River.

June 3, 1896	$10,000
June 4, 1897	350,000
July 1, 1898	152,250
Total	512,250

For commercial statistics see report for operating and care of Louisville and Portland Canal.

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REPORT OF MR. J. H. CASEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
LOUISVILLE AND PORTLAND CANAL,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations on the enlargement of the head of the Louisville and Portland Canal, under the approved project for improving the Falls of Ohio River, for the fiscal year ending June 30, 1898:

The principal work carried on during the year was the completion of the north basin wall at the westerly end of the enlargement, grading and revetting slope, dredging mud, excavating rock, fitting up and equipping two air-compressor scows for drilling purposes, and repairing plant.

NORTH BASIN WALL.

The work was commenced in August and completed in December. This wall extends from the completed wall west of Varble Chute 319 feet to the east end of new north canal wall. The masonry commences on the rock ledge, elevation 39.8 (canal datum), and is carried to elevation 50.

Elevation, 39.8, being 6.7 feet above grade of basin, to get a smooth face on the rock ledge 2½-inch holes, 6 inches center to center, were drilled along the entire face of wall; every third or fourth hole was loaded with a small charge of 40 per cent dynamite, and about six charges were fired simultaneously. The fracture was in all cases along the line of holes, leaving the face of ledge in fairly smooth condition. Face stone and cement were the only materials purchased for the wall. Rubblestone for backing was taken from wherever most available, the largest quantity being taken from basin in front of the wall.

Cost of face stone purchased from the Salem-Bedford Stone Company under contract dated August 2, 1897, $1,949.18.

Total cubic yards masonry	1,086.4
Cost per cubic yard masonry	$4.54

REVETMENT.

The slope above the new wall was graded and revetted with rubblestone from the east end of canal revetment to Varble Chute. The stone for the work was taken from wherever available and laid by common labor.

	Cents.
Grading, 297 cubic yards, per cubic yard	35
Revetting, 1,191 square yards, per square yard	74.8

EXCAVATION.

The work preparatory to excavation—making roads, draining pit, setting up boilers, pumps, building earthen dams, etc.—was commenced in July, 1897.

The rock excavation at the lower end of basin was commenced in July and completed, with the exception of a few projecting rocks, to Station 5, a distance of 515 feet east of the east rest pier of the Fourteenth Street Bridge, June 30, 1898.

The rock excavated at this point—about 4,675 cubic yards—was loaded into carts and hauled from the pit by Messrs. Gast & Co. at their own expense. One thousand seven hundred and fifteen cubic yards were stored north of the north canal and basin wall, to be used as backing for the extension of the new north and south walls, and 3,634 cubic yards removed by dredging. All of the large loose rock, 1,231 cubic yards, was stored north of the north wall.

Late in the season, when it was found that all of the loose rock could not be removed before winter set in, about 2,538 cubic yards were broken into small fragments, so as to facilitate removal by dredging. When not engaged in canal work, the three dredges were employed in dredging mud and loose rock from the basin.

Total excavation for season:

	Cubic yards.
Solid rock, measured in place	10,024
Loose rock, estimated	1,231
Old wall removed	186
Total rock excavated	11,441
Mud excavation, scow measurement	49,514
Earth excavation for north wall extension	985
Total earth excavation	50,499

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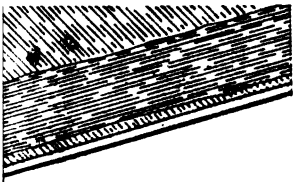

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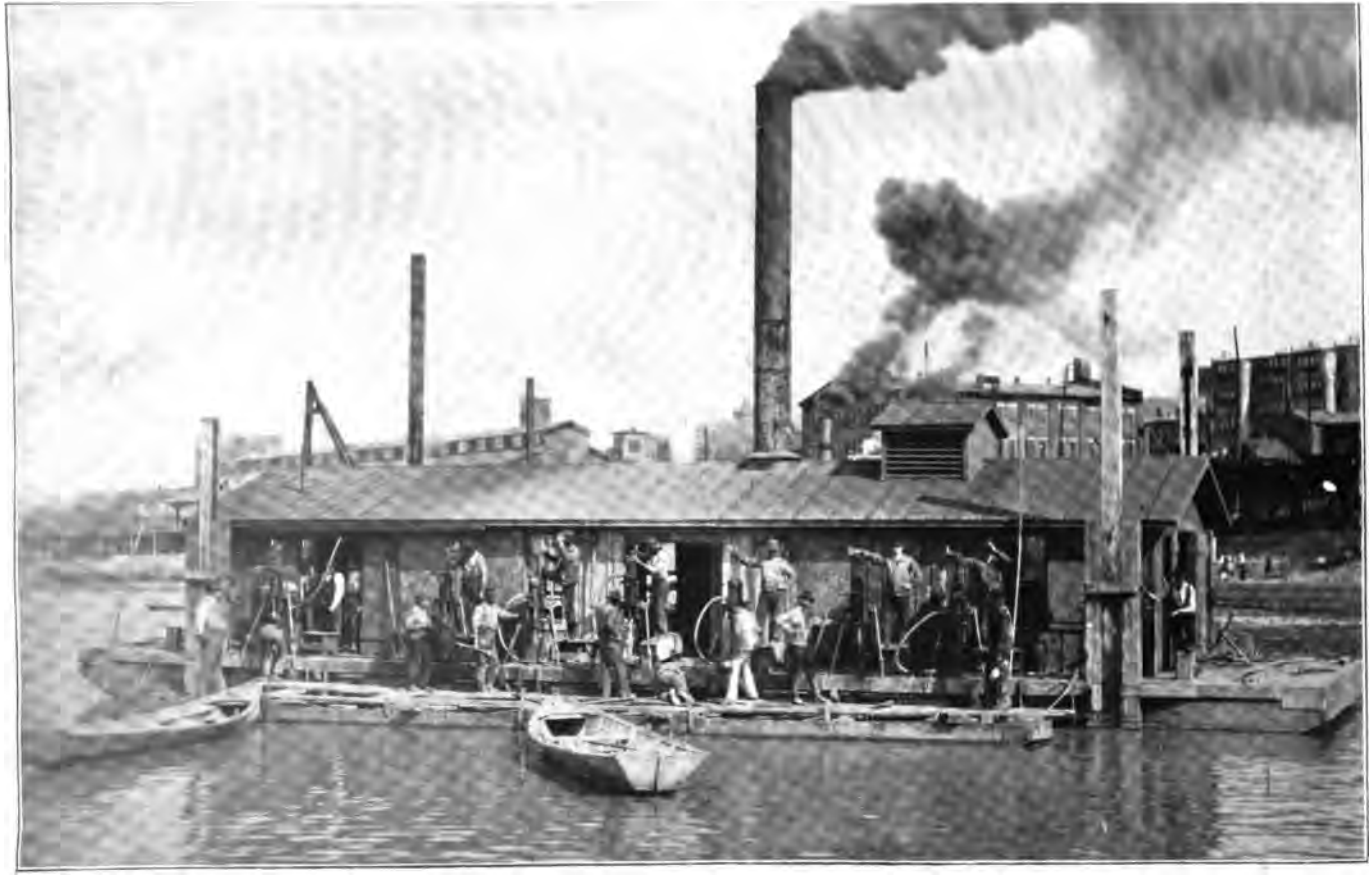

COMPRESSOR BOAT AND DRILLS.

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DRILLING, DRY AND SUBMARINE.

From the commencement of the season's work up to December 30 the water was drained off of the excavation and steam used to operate the drills.

On the resumption of work, February 7, a plant for submarine work was used, consisting of two scows, 72 by 22 feet, each fitted up with boiler and an Ingersoll-Sergeant straight-line air compressor, 16 by 18 by 18 inches, for supplying power to run drills. The drills were worked over the sides of the scows, seven on each, mounted on ordinary tripods. Two legs of the tripods were supported by an outrigger bolted to the gunwale, and the third leg rested on the guard of the scow. Considerable difficulty was encountered in drilling east of Fourteenth Street Bridge. The ledge was full of seams and always covered with a strata of mud, gravel, and small rock from 1 to 2 feet in depth.

Two hours per day were lost in moving drill scows out of the way of passing boats, tows, and for blasting.

On June 3, 1898, the plant was removed to ledge opposite Sixth street, and has since been engaged in drilling under the most favorable conditions.

Drilling, loading, and blasting.

	West of Fourteenth Street Bridge, drilling by steam on dry ledge.	East of Fourteenth Street Bridge.		Opposite Sixth street, drilled by air and not blasted.
		Drilling by air, submarine.	Drilled by air and not blasted.	
	Feet.	*Feet.*	*Feet.*	*Feet.*
Aggregate length of holes drilled	208,487	22,350	4,610	20,113
Average depth of holes	7.6	5.9	5.2	4.7
Depth of water over rock	Dry.	3 to 11	3 to 11	3 to 6.5
Average rate per drill per day of 8 hours	45	41	51	84
	Cents.	*Cents.*	*Cents.*	*Cents.*
Cost per foot of drilling and loading holes	.09	18.7	.....	.....
Cost per foot of drilling and plugging	.....	.....	13.6	8.1
	Pounds.	*Pounds.*		
Forcite dynamite, weight per cubic yard of work blasted	56	a 1.8	.....	.....
	Cents.	*Cents.*		
Cost per cubic yard of drilling, loading, and blasting	33	79.4	.....	.....

a 75 per cent.

REPAIRS.

During the season the pumps and engines were overhauled and thoroughly repaired. Seven side-dump cars were converted into end-dump cars and 58 dump cars were repaired.

Very respectfully, your obedient servant,

J. H. CASEY, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers.

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations on improving Falls of Ohio River for fiscal year ending June 30, 1898:

The work of repairing the guiding dike at the upper end of the canal, which was partially completed during the last month of the previous fiscal year, was continued until July 26, on which date high water interfered. Work was resumed August 10, and the repairs completed August 13. The total length rebuilt was 583 feet. The cost was $2,310.16, of which $1,511.61 was expended for labor and moving material, and $798.55 for timber and iron.

During the winter of 1896–97 about 175 feet of the cross dam between the Middle and Indiana chutes was carried away by ice and drift. On August 16, 1897, material

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was transferred to the gap and the construction of a temporary dam around the opening begun. Thirteen cribs, 16 feet long, 5 feet wide, and ranging from 5 to 7 feet high were used in the temporary dam, which was completed on September 23. The cost for labor and moving material was $1,119.86; for timber and iron, $274.27; total, $1,394.13. A photograph, marked H, showing gap and temporary dam under construction, is submitted.

INDIANA CHUTE.

Head of chute, between cross dam and railroad bridge.—Previous to 1897 the removal of reefs and projecting points at the head of Indiana Chute was accomplished by means of breakwaters. These were light cribs placed above and partially around the obstruction to be removed, which reduced the water below and inside, but rarely uncovered the ledge or reef. The chute was surveyed in 1879, but the cross sections were on the basis of 50-foot squares and the points taken by triangulation, so that many of the projections were missed. It was determined, therefore, to place a temporary dam at the head of the chute, entirely closing the opening, by means of which it is expected that all points above the grade line would be exposed and an opportunity afforded for a more thorough cross section of the bottom.

The opening in the cross dam at the head of the chute is 629 feet, and the current has about a 10-mile velocity. The temporary dam was of the "A" pattern, and the frames were secured by ordinary spikes. The method of bracing is shown in the accompanying sketch. Each section was 16 feet long and contained three ribs, the cribs being 8 feet high and 14 feet at the base. A derrick boat and barge, the latter containing timber, were anchored above the opening by means of a series of 2-inch iron bars, from 8 to 10 feet long, let into drill holes in the solid rock bottom. These bars were so placed that the barge and derrick boat could be moved to any position above the opening. The cribs were built on the end of the barge, and from there lifted by the derrick and placed in position. A wheelbarrow run was provided on the lower side of last section, and broken stone was deposited on the floor as soon as the crib was set. The method of handling and placing the cribs is shown in the accompanying photographs. Forty sections were used in the dam. The first crib was placed on the 16th and the last one on the 30th of September, the work having been retarded somewhat by the rough character of the bottom of the chute. Sheeting, composed of oak planks 2 inches by 12 inches, was placed on the upper side of the dam, and drilling was begun on October 2. The bottom of the chute was quite uneven, and the leakage at first was considerable, but by the use of rag weeds, which grew in profusion on the shore of the river, most of the openings were closed.

The accompanying photograph shows the dam immediately after the sheeting was put on. As soon as the river was shut off from the chute it was apparent that the amount of work to be done was much larger than had been anticipated, and a night force was started on October 6. The accompanying drawing shows the areas drilled and blasted to grade, and the work yet to be done. The material, after blasting, was deposited in the deeper parts of the channel, below grade. Work was pushed until November 9 with a loss of five days by reason of rain. On the latter date the river rose so rapidly that it came over part of the temporary dam, flooding the channel below. Tools and appliances were placed on boats and stored at the United States warehouse, and the temporary dam was removed by means of the derrick boat. On this part of the chute there were drilled and blasted 12,218 holes, ranging from 1½ to 3 feet deep. Eight thousand pounds of explosives were expended. About 4,300 cubic yards of solid rock were excavated to the grade line. The expenditures for the temporary dam were: Labor, $1,996.63; material, $916.90; total, $2,913.53. For excavation: Labor, $17,178.84; material, $2,272.93; total, $19,451.87.

The following illustrations, pertaining to this part of the work, are respectfully submitted: (1) Sketch marked A, showing end view of crib. (2) Sketch marked B, showing method of handling derrick boat and barge. (3) Sketch marked C, showing areas drilled and blasted. (4) Photographs marked D, showing temporary dam in course of construction. (5) Photograph marked E, showing dam finished. (6) Photographs marked F, showing bottom of channel at various points; and (7) photograph marked G, showing view of channel from railroad bridge.

WILLOW POINT.

The excavation of the reef at Willow Point and the construction of the stone dike west of that point were resumed on September 24. Part of the ledge was drilled in 1892, so that only a small amount of drilling was necessary during this season. The gap in the base of the dike just below Willow Point was first cleared of mud and then filled with stone from the excavation. The base of the dike, built in 1892, was somewhat worn by the action of ice, and it was leveled up to about reference 21.5 and the construction of the dike proper begun. The material was hauled in carts and about 1,000 linear feet of dike was built 4½ feet high. The slopes were

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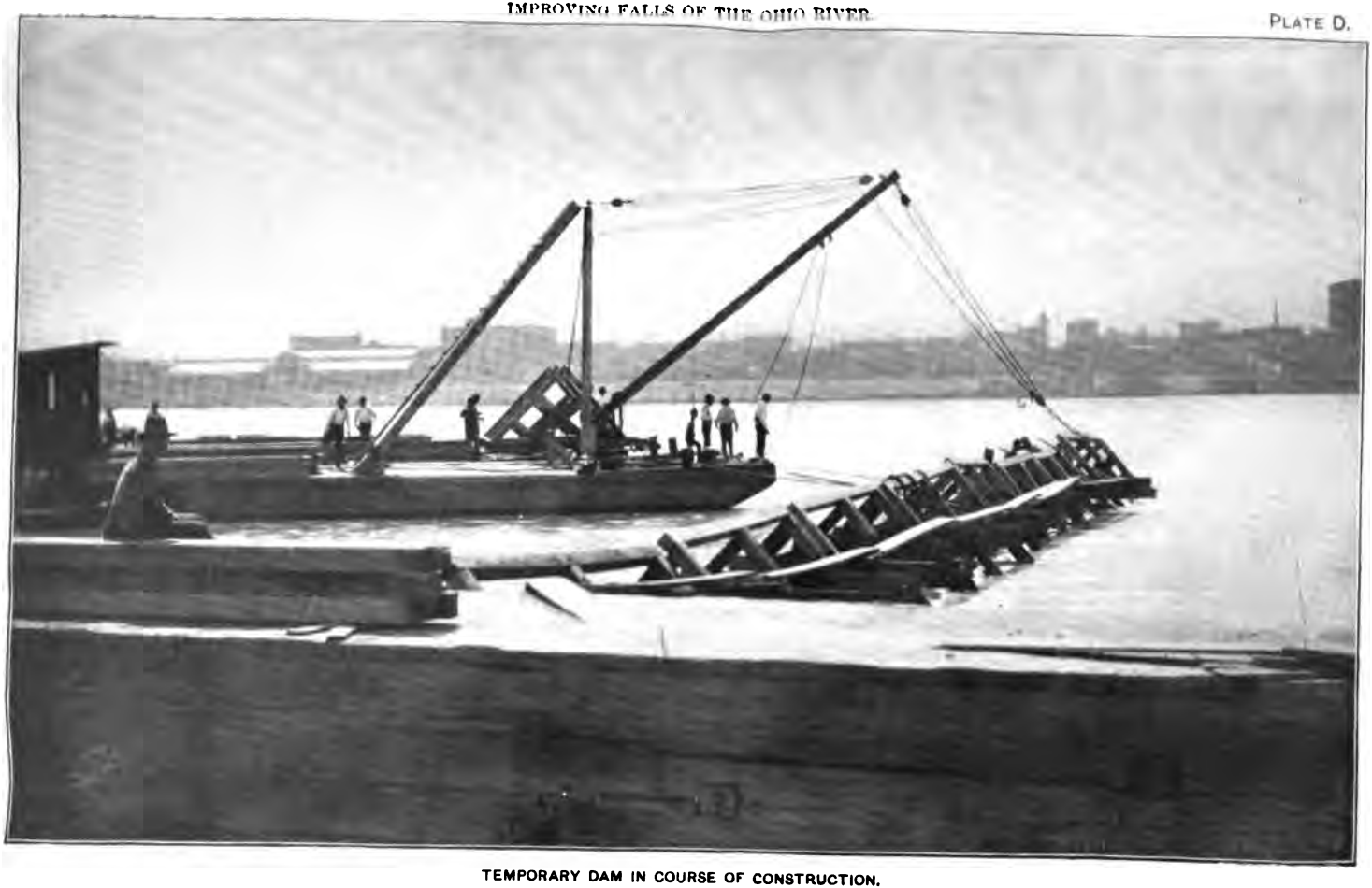

TEMPORARY DAM IN COURSE OF CONSTRUCTION.

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TEMPORARY DAM IN COURSE OF CONSTRUCTION.

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TEMPORARY DAM IN COURSE OF CONSTRUCTION.

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TEMPORARY DAM IN COURSE OF CONSTRUCTION.

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SHOWING DAM FINISHED.

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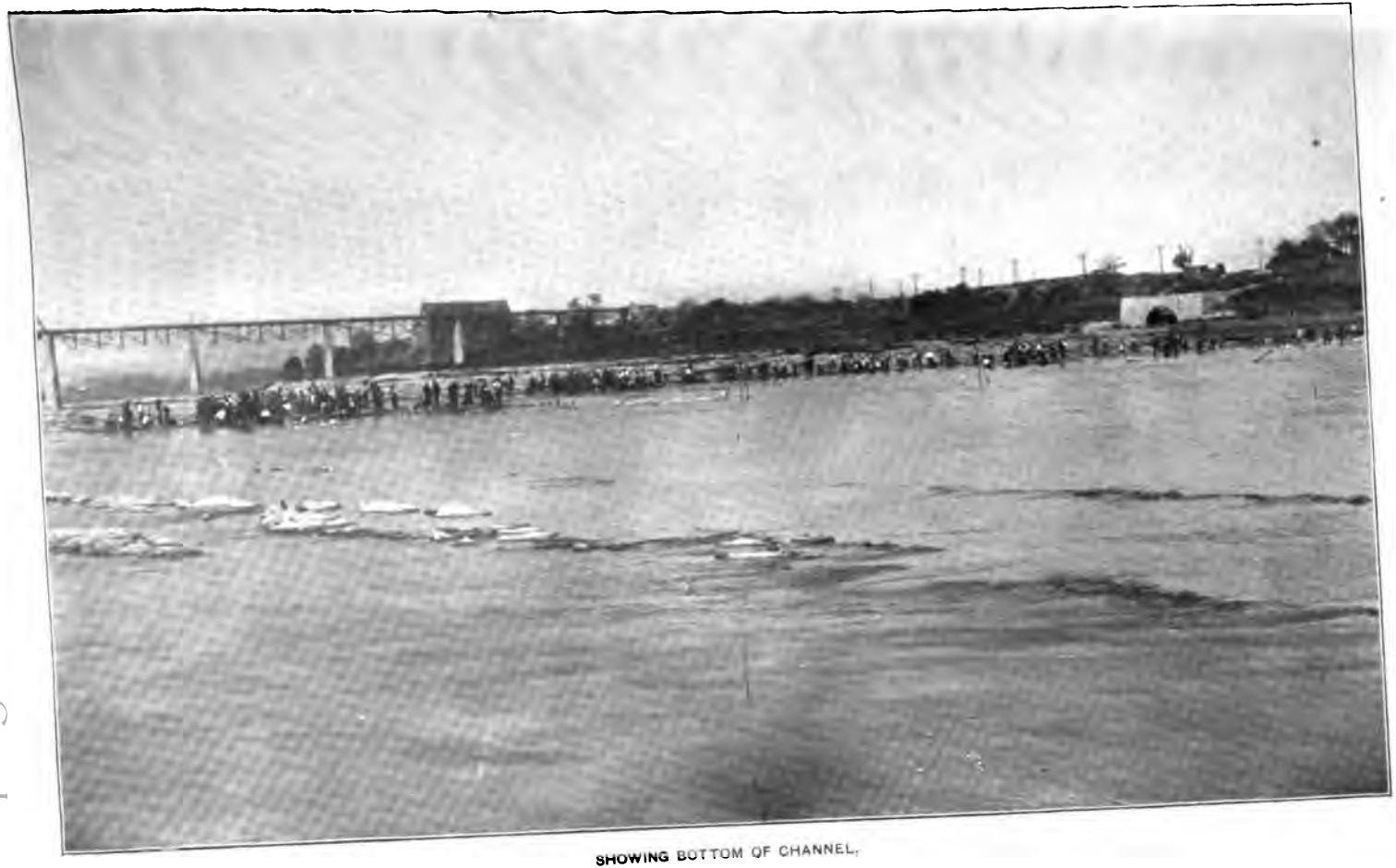

SHOWING BOTTOM OF CHANNEL.

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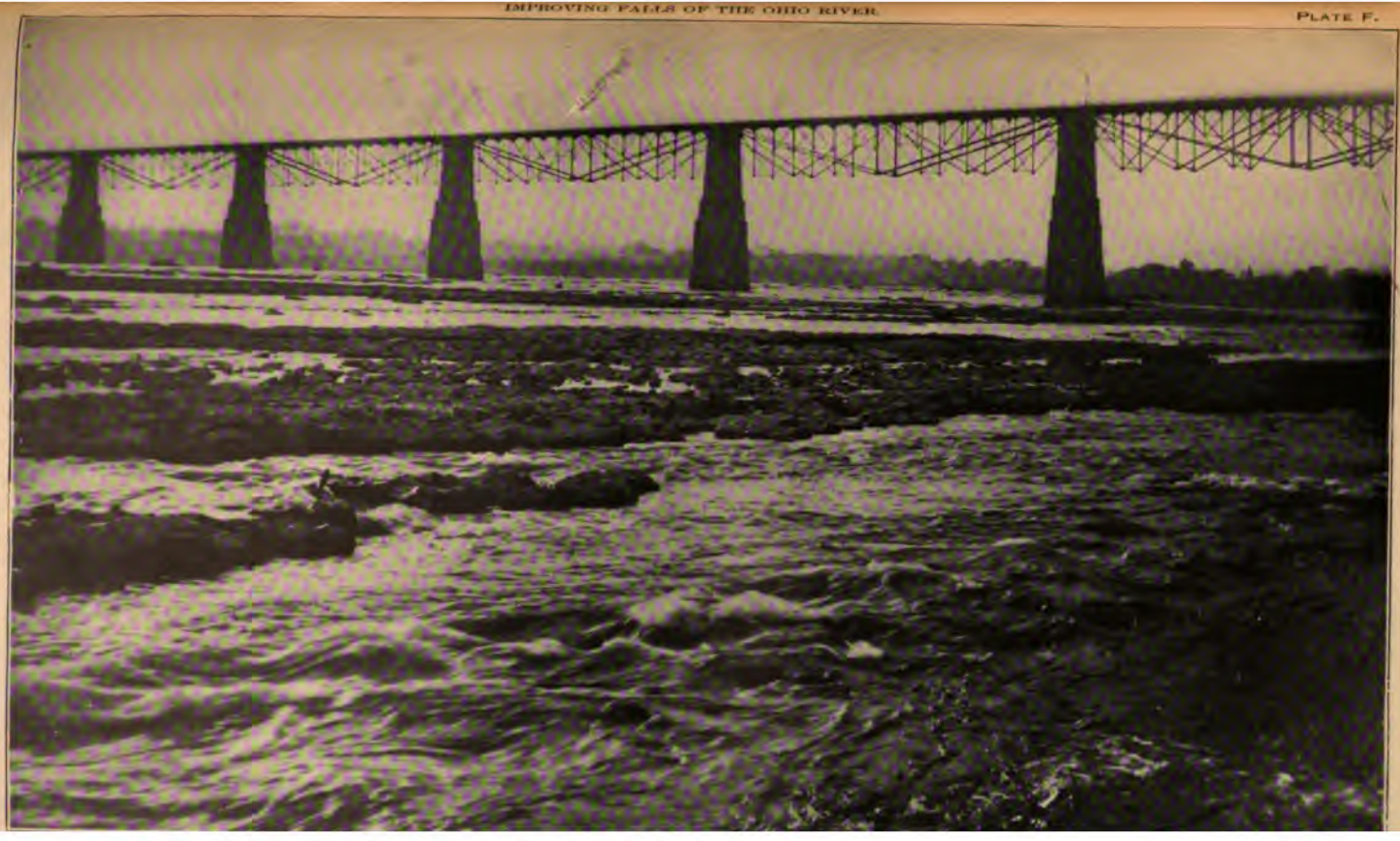

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VIEW OF CHANNEL FROM RAILROAD BRIDGE.

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PLATE H.

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paved and have stood the exposure of the winter months without any apparent wear. There were excavated and hauled to the dike 5,322 cubic yards of stone, measured loose; blasted, but not removed, 6,403 cubic yards; total, 11,725 cubic yards. About 100 cubic yards of earth and mud were removed from the gap in the base of the dike. Explosives expended, 3,522 pounds. The cost of labor and material was $5,302.05, or about 99 cents per cubic yard, measured in the dike.

There remains to be built 6.3 feet of the upper part of the dike. The work was closed November 9 on account of high water. Preparations for work during the season of 1898 were begun on June 9. A boiler boat for furnishing steam was fitted up, tools and material were loaded, and the plant taken over the falls and located at the lower end of Willow Point. Pipe lines for conveying steam to the drills have been laid, and it is expected that drilling will be commenced on July 1. A drawing marked J, showing Willow Point, Wave Rock, and the work accomplished in 1897, is submitted.

MISCELLANEOUS.

The movable dam, Indiana Chute, was raised in October and several of the trestles repaired.

The dump cars and boilers belonging to the work were thoroughly overhauled and repaired.

A survey of Willow Point was made in July and the upper part of Indiana Chute was cross sectioned in October.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 2.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

The project and estimate for operation connected with this canal during the fiscal year ending June 30, 1898, contained the following items:

Regular force	$43,140.00
Extra labor	4,000.00
Repairs	7,000.00
Miscellaneous, fuel, oil, etc	6,500.00
Combined dredge and derrick boat	4,648.65
New hull, drill boat	1,765.50
Enlargement of coal bin	3,380.77
Two new dump scows	4,992.27
Dry-dock gates	980.23
Retaining wall, dry dock	9,231.11
Retaining wall, unprotected bank	22,264.23
Automatic gate	6,297.47
Contingencies	6,000.00
Total	120,200.23

The first four items provide for regular employees for operating the locks, the towboat and dredge crews, the shop employees, share of expenses in district office, and ordinary miscellaneous supplies, repairs, and expenses. The remaining items provide for repairs of definite character and of sufficient magnitude to be considered separately.

The details of the year's operations are fully presented in the report of Mr. J. H. Casey, assistant engineer, appended hereto and containing the usual commercial statistics.

As a matter of interest to those engaged in similar work, I have had drawings prepared of the combined dredge and derrick boat constructed during the year for use on the canal, marked —.

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The dredge can be operated at any stage of water from 2 to 40 feet. Operated as a grapple dredge it has a capacity, using a 1-yard grapple bucket of the Lancaster type, of from 60 to 100 cubic yards per hour, and has averaged as much work as the large yard-and-a-half dipper dredge in use here, and which cost $20,000. As an hydraulic dredge it is used at high water, when the locks are closed, in pumping mud from the chamber of the lower lock and the bar below the locks, doing in a few hours work which required as many days with the dipper dredge.

When not required as a dredge it can be used as a derrick boat of 6 tons capacity.

The cost of the boat was $4,576.02, not including the cost of the boiler and 12-inch centrifugal pump with its engine, which were on hand.

Following are statements of expenditures, collections, etc., for the year:

Detailed statement of expenditures made in connection with the work of operating and care of the Louisville and Portland Canal, Louisville, Ky., during the fiscal year ending June 30, 1898.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	1	Pay roll	Services	$2,437.50
	2	do	do	1,526.35
	3	do	do	914.90
	4	do	do	461.80
	5	T. H. Baker, postmaster	Post-office box rent	5.00
	6	Louisville Water Co	Water supply	25.58
	7	Northern Lake Ice Co	Ice	25.86
	8	Brennan & Co., Southwestern Agricultural Works.	Sawmill	289.75
	9	W. B. Belknap & Co	Chain, etc	180.63
	10	Albrecht & Heick	Shovels, etc	102.20
	11	The Ohio Valley Telephone Co	Telephone service	73.60
	12	Bridges-Strassel Co	Paint, etc	71.84
	13	Andrew Cowan & Co	Waste	34.91
	14	J. H. Casey, assistant engineer	Traveling expenses	6.80
	15	Edward Mead	Testing cement	12.50
	16	John P. Morton & Co	Stationery	3.62
	17	The Badgley & Hoerter Co	Photographic supplies	2.36
	18	Jas. Clark, jr., & Co	Lead wire	8.59
	19	Sulzer-Vogt Machine Co	Castings	61.18
	20	Milton W. Barkhouse	Fittings, etc	96.21
	21	W. B. Belknap & Co	Hardware	41.67
August	1	Pay roll	Services	2,381.00
	2	do	do	1,414.42
	3	do	do	988.58
	4	do	do	667.59
	5	do	do	26.70
	6	Albert Jecker	Team hire	75.47
	7	Finis Cartwright & Son	Broken stone	351.01
	8	Louisville Water Co	Water supply	24.56
	9	Alexr. Harthill, jr	Horseshoeing	2.30
	10	Henry S. Beyer	Forage	24.53
	11	J. B. Speed & Co	Cement	29.26
	12	Bridges-Strassel Co	White lead	30.60
	13	Northern Lake Ice Co	Ice	34.52
	14	W. W. Hite & Co	Oakum, etc	106.34
	15	Peaslee-Gaulbert Co	Paint, etc	177.89
	16	Utica Lime Co	Cement	647.85
	17	G. M. Allison & Co	Typewriter	90.00
	18	The Todd-Donigan Iron Co	Chain	51.45
	19	W. B. Belknap & Co	Hardware	12.90
	20	A. Button & Son	Soap	7.30
	21	Andrew Cowan & Co	Belting	6.02
	22	Pay roll	Services	24.91
	23	do	do	600.00
September	1	do	do	2,295.00
	2	do	do	1,219.16
	3	do	do	608.00
	4	do	do	834.12
	5	Louisville Water Co	Water supply	25.96
	6	Richard Jennings	Services	12.00
	7	Shippen Bros	Lumber	296.17
	8	Sterling Paint and Color Co	Supplies	132.33

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Detailed statement of expenditures made in connection with the work of operating and care of the Louisville and Portland Canal, Louisville, Ky., etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
September...	9	J. B. Speed & Co	Cement	$83.86
	10	W. W. Hite & Co	Oakum, etc	87.59
	11	Andrew Cowan & Co	Hose	69.60
	12	Indiana Forge and Rolling Mill Co	Iron	50.07
	13	Fred W. Keisker & Son	Tables	40.00
	14	Northern Lake Ice Co	Ice	34.90
	15	Finis Cartwright & Son	Broken stone	18.37
	16	Albrecht & Heick	Hardware	15.04
	17	Frederick Diehl	Stationery	13.85
	18	Henry S. Beyer	Forage	11.40
	19	R. B. & G. W. Shaw	Testing cement	9.75
	20	O'Neil Coal and Coke Co	Coke	8.24
	21	Henry Disston & Sons	Repairing saws	4.95
	22	Geher & Son	Oil cans	4.00
	23	James Lockhart	Services	3.00
	24	Alexr. Harthill, jr	Horseshoeing	2.30
	25	W. B. Belknap & Co	Supplies	344.07
	26	Peaslee-Gaulbert Co	Oil, etc	46.79
	27	Milton W. Barkhouse	Hose, etc	15.07
	28	Peaslee-Gaulbert Co	Scrub brushes	12.00
	29	Jas. Clark, jr., & Co	Repairing electric plant	6.50
	30	Pay roll	Services	143.22
October	1	do	do	2,380.00
	2	do	do	1,288.62
	3	do	do	934.28
	4	do	do	353.29
	5	Louisville Water Co	Water supply	26.76
	6	Salem Bedford Stone Co	Stone	5,610.29
	7	T. H. Baker, postmaster	Post-office box rent	5.00
	8	J. B. Speed & Co	Cement	141.54
	9	Finis Cartwright & Son	Broken stone	80.48
	10	Phœnix Carbon Manufacturing Co	Carbons	30.00
	11	Henry S. Beyer	Forage	13.32
	12	Pay roll	Services	62.80
	13	The Ohio Valley Telephone Co	Telephone service	75.86
	14	W. H. McKnight, Sons & Co	Shades, etc	44.10
	15	Northern Lake Ice Co	Ice	32.76
	16	R. B. & G. W. Shaw	Testing cement	10.75
	17	Burrell & Walker Clay Manufacturing Co.	Chimney tops	6.00
	18	Alexr. Harthill, jr	Horseshoeing	1.10
	19	Henry Koehler & Co	Lumber, etc	163.77
	20	Andrew Cowan & Co	Packing	84.16
	21	W. B. Belknap & Co	Hardware	77.38
	22	The Ahrens & Ott Manufacuring Co.	Injector	60.00
	23	Wheeler Carriage Co	Repairing wagon, etc	48.35
	24	Chas. Hegewald Co	Smokestack	28.00
	25	Peaslee-Gaulbert Co	Oil tanks, etc	16.03
	26	Geher & Son	Water cooler	4.50
	27	Jas. Clark, jr., & Co	Wire	2.02
	28	A. Button & Son	Matches	1.00
	29	The Todd-Donigan Iron Co	Hardware	287.94
November...	1	Pay roll	Services	2,367.50
	2	do	do	1,203.67
	3	do	do	831.57
	4	do	do	388.83
	5	Louisville Water Co	Water supply	15.17
	6	Milton W. Barkhouse	Fittings, etc	112.77
	7	Wood Brothers	Papering	32.48
	8	Shippen Brothers	Timbers	558.00
	9	McCullough-Dalzell Co	Lead crucibles	2.72
	10	R. B. & G. W. Shaw	Inspecting and testing cement.	2.85
	11	Alexr. Harthill, jr	Shoeing horses	2.40
	12	J. B. Speed & Co	Cement	33.63
	13	The Drummond Manufacturing Co	Castings	38.23
	14	Geher & Son	Oil cans	8.00
	15	Henry S. Beyer	Forage	17.49
	16	Northern Lake Ice Co	Ice	25.76
	17	Frederick Diehl	Stationery	10.46
	18	Pay roll	Services	25.33
	19	Sulzer-Vogt Machine Co	Mud drums, etc	358.46
	20	Peaslee-Gaulbert Co	Oil, etc	107.35
	21	Henry Koehler & Co	Timber	1,240.97
December...	1	Pay roll	Services	2,351.67
	2	do	do	1,140.86
	3	do	do	877.24
	4	do	do	289.50
	5	Louisville Water Co	Water supply	13.10

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Detailed statement of expenditures made in connection with the work of operating and care of the Louisville and Portland Canal, Louisville, Ky., etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
December....	6	The Todd-Donigan Iron Co	Forge, etc	$17.01
	7	Louisville Fire Brick Works	Fire clay	6.25
	8	Andrew Cowan & Co	Leather, etc	116.21
	9	Recktenwald Brothers	Spouting	12.35
	10	Chas. Hegewald Co	Repairing boiler	131.77
	11	.....do	Bulkheads, etc	200.00
	12	Pay roll	Services	42.20
	13	Chas. Hegewald Co	Repairing dredge	121.00
	14	Everett S. Miller, transitman	Traveling expenses	34.70
	15	C. H. Koster	Flags	12.30
	16	Advance Coal Co	Coal	1,021.18
	17	Frank Weber & Co	Wagon wheels	24.00
	18	Chattanooga Steel Roofing Co	Creating, etc	42.85
	19	Alexr. Harthill, jr	Shoeing horse	1.20
	20	Pay roll	Services	2.40
	21	Jas. Clark, jr., & Co	Annunciator, etc	33.36
	22	Albrecht & Heick	Sledge handles, etc	10.71
	23	Peaslee-Gaulbert Co	Glass, etc	53.15
	24	Phil A. Vogel & Sons	Valves, etc	56.06
	25	Milton W. Barkhouse	Asbestus cement	205.05
	26	Frederick Diehl	Stationery	8.72
	27	Shippen Brothers	Lumber	695.35
	28	The Todd-Donigan Iron Co	Tire shrinker, etc	34.95
	29	W. B. Belknap & Co	Supplies	118.04
	30	Northern Lake Ice Co	Ice	7.02
	31	Louisville Water Co	Water supply	36.92
	32	Henry Disston & Sons	Saw, etc	43.00
1898.				
January.....	1	Pay roll	Services	1,857.33
	2	.....do	.....do	1,166.78
	3	.....do	.....do	1,211.28
	4	.....do	.....do	317.97
	5	.....do	.....do	135.20
	6	T. H. Baker, postmaster	Post-office box rent	5.00
	7	Cleveland, Cincinnati, Chicago and St. Louis Rwy.	Freight charges	1.61
	8	Everett S. Miller, transitman	Traveling expenses	35.23
	9	Celie Winstead	Services	7.50
	10	American Hoist and Derrick Co	Turning winch, etc	415.00
	11	Byrne & Speed	Coal	119.00
	12	The Drummond Manufacturing Co.	Castings	105.60
	13	Indiana Forge and Rolling Mill Co.	Iron	305.29
	14	Alexr. Harthill, jr.	Horseshoeing	1.20
	15	R. M. Cunningham	Lumber	429.15
	16	Frederick Diehl	Supplies	17.47
	17	Jas. Clark, jr., & Co	.....do	7.80
	18	J. B. Speed & Co	Salt	4.90
	19	C. D. Jewell	Newspaper	3.90
	20	Louisville Towel Supply Co	Furnishing towels	6.00
	21	The Ohio Valley Telephone Co	Telephone service	74.70
	22	Northern Lake Ice Co	Ice	1.17
	23	The Ahrens & Ott Manufacturing Co	Fittings	10.57
	24	Sterling Paint and Color Co	White lead, etc	37.25
	25	Henry S. Beyer	Forage	25.12
	26	John White & Co	Tallow	3.00
	27	Milton W. Barkhouse	Pulley	2.25
	28	John Jackson	Services	15.90
	29	John Unz & Son	Supplies	8.36
	30	Courier-Journal Job Printing Co	.....do	3.00
	31	Fred W. Keisker & Son	Beds, etc	70.80
	32	Jas. D. Murray	Exterminator	3.75
	33	W. B. Belknap & Co	Tiller rope, etc	47.88
February....	1	Pay roll	Services	2,302.50
	2	.....do	.....do	1,361.56
	3	.....do	.....do	305.31
	4	Louisville Water Co	Water supply	11.67
	5	Ostermoor & Co	Mattresses, etc	44.40
	6	Advance Coal Co	Coal	1,056.07
	7	Andrew Cowan & Co	Hose, etc	226.66
	8	Kaufman, Straus & Co	Dry goods	243.95
	9	Northern Lake Ice Co	Ice	1.75
	10	Chas. Hegewald Co	Castings, etc	22.54
	11	Henry Vogt Machine Co	Repairing boiler	11.00
	12	Pay roll	Services	16.67
	13	W. H. McKnight, Sons & Co	Linoleum	58.57
	14	The Ahrens & Ott Manufacturing Co	Flanges, etc	15.54
	15	National Foundry and Machine Co.	Material and services	5.75
	16	Phil A. Vogel & Sons	Supplies	26.28

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Detailed statement of expenditures made in connection with the work of operating and care of the Louisville and Portland Canal, Louisville, Ky., etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
February	17	The Todd-Donigan Iron Co	Supplies, etc	$37.75
	18	W. W. Hite & Co	Duck	33.02
	19	Louisville Bridge and Iron Co	Turntable wheels	59.95
	20	Frank Weber & Co	Repairing wagon	18.75
	21	Peaslee-Gaulbert Co	Supplies	3.80
	22	Alexr. Harthill, jr	Horseshoeing	2.80
	23	Albrecht & Heick	Supplies	5.85
	24	F. C. Nunemacher	Blank book	2.50
	25	Pay roll	Services	675.00
March	1	.....do	.....do	2,123.17
	2	.....do	.....do	968.32
	3	.....do	.....do	1,106.17
	4	.....do	.....do	287.22
	5	Louisville Water Co	Water supply	34.79
	6	Lidgerwood Manufacturing Co	Engine	690.00
	7	Elizabeth Marine Ways Co	Mud scows	3,800.00
	8	J. H. Casey, assistant engineer	Traveling expenses	35.50
	9	The Cincinnati Railway Supply Co.	Steel, etc	100.08
	10	.....do	Turn-buckles, etc	47.90
	11	Indiana Forge and Rolling Mill Co.	Iron	73.40
	12	Jas. Clark, jr., & Co	Supplies	40.50
	13	A. Button & Son	Soap, etc	16.60
	14	Alexr. Harthill, jr	Horseshoeing	2.80
	15	The McKinley Coal Co	Towing	49.75
	16	Henry S. Beyer	Forage	12.51
	17	W. & A. C. Semple	Files, etc	21.46
	18	W. B. Belknap & Co	Supplies	192.24
	19	National Foundry and Machine Co.	Castings, etc	3.96
	20	Albrecht & Heick	Glue, etc	4.35
	21	Andrew Cowan & Co	Rope, etc	244.79
	22	J. B. Speed & Co	Cement	11.76
	23	Frederick Diehl	Supplies	2.30
	24	Louisville Fire Brick Works	Brick	9.00
	25	Ed. Wurts	Services	9.60
	26	Peaslee-Gaulbert Co	Supplies	122.45
	27	Brennan & Co. Southwestern Agricultural Works.	Dog rack	6.00
	28	Phil A. Vogel & Sons	Hose	6.75
	29	W. W. Hite & Co	Tallow	3.00
April	1	Pay roll	Services	2,178.84
	2	.....do	.....do	987.17
	3	.....do	.....do	815.62
	4	.....do	.....do	292.14
	5	T. H. Baker, postmaster	Post-office box rent	5.00
	6	Louisville Water Co	Water supply	16.16
	7	Stephen Pitts	Services	20.00
	8	Dave Robertson	.....do	5.33
	9	The Ohio Valley Telephone Co	Telephone services	74.62
	10	Northern Lake Ice Co	Ice	1.58
	11	W. F. Robertson Steel and Iron Co.	Steel and iron	24.10
	12	Peaslee-Gaulbert Co	Tableware	6.49
	13	Imperial Laundry	Laundrying	5.00
	14	Geher & Son	Oil cans	12.00
	15	Arthur Kaye	Crockery	38.30
	16	Henry S. Beyer	Forage	12.67
	17	C. K. Caron	Directory	6.00
	18	A. Button & Son	Matches	2.00
	19	B. F. Sturtevant Co	Blower fitting	8.00
	20	W. B. Belknap & Co	Grindstone	10.85
	21	Jas. Clark, jr., & Co	Supplies	4.04
	22	Courier-Journal Job Printing Co	Binding files	2.00
	23	C. D. Jewell	Newspaper	1.95
	24	Albrecht & Heick	Supplies	29.29
	25	Frederick Diehl	Stationery	16.84
	26	W. B. Belknap & Co	Iron and steel	226.78
	27	Henry S. Beyer	Forage	12.35
	28	W. F. Robertson Steel and Iron Co.	Steel	5.84
	29	Peaslee-Gaulbert Co	Supplies	27.02
	30	Milton W. Barkhouse	.....do	205.87
	31	Grainger & Co	Steel pinion, etc	15.87
May	1	Pay roll	Services	2,316.67
	2	.....do	.....do	1,315.67
	3	.....do	.....do	747.69
	4	.....do	.....do	265.83
	5	Louisville Water Co	Water supply	37.83
	6	The James McDonald & Sons Co	Copper, etc	18.30
	7	Courier-Journal Job Printing Co	Job printing	14.00
	8	J. B. Speed & Co	Cement	11.76

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Detailed statement of expenditures made in connection with the work of operating and care of the Louisville and Portland Canal, Louisville, Ky., etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
May	9	Frank Campbell	Services	$22.00
	10	Chas. Hegewald Co	Boiler, etc	545.00
	11	Henry Koehler & Co	Timber	263.25
	12	....do	Lumber	167.50
	13	Alexr. Harthill, jr	Horseshoeing	5.60
	14	Northern Lake Ice Co	Ice	1.86
	15	Standard Oil Co	Oil	35.33
	16	The Ahrens & Ott Manufacturing Co	Gauge cocks, etc	5.13
	17	W. B. Belknap & Co	Iron and steel	22.44
	18	W. W. Hite & Co. (Incorporated)	Twine	2.00
	19	Henry Vogt Machine Co	Sheaves, etc	67.88
	20	Lizette Kingsbury, administratrix	Services of William T. Kingsbury, deceased.	5.88
	21	Phil A. Vogel & Sons	Supplies	49.76
	22	Louisville Water Co	Water supply	15.26
	23	Geher & Son	Repairs to lock, engine house	35.40
	24	Frederick Diehl	Paper	2.25
	25	Andrew Cowan & Co	Pulley	7.35
	26	Standard Oil Co	Oil	11.22
	27	Joseph P. Lynch	Services	150.00
	28	Pay roll	....do	650.00
	29	Peaslee-Gaulbert Co	Supplies	4.10
	30	Albrecht & Heick	Drills, bolts, scythes, etc	11.20
June	1	Pay roll	Services	1,887.67
	2	....do	....do	991.16
	3	....do	....do	662.87
	4	....do	....do	288.06
	5	Frank Dezelia	....do	27.00
	6	Northern Lake Ice Co	Ice	10.44
	7	Henry Koehler & Co	Lumber	316.80
	8	Shippen Brothers	....do	17.04
	9	Phil A Vogel & Sons	Supplies	35.99
	10	McKibbin Brothers	....do	5.65
	11	J. B. Speed & Co	Cement	19.88
	12	Henry S. Beyer	Forage	12.44
	13	....do	....do	12.45
	14	Waters & Garland	Leather belts	8.67
	15	Alexr. Harthill, jr	Horseshoeing, etc	6.80
	16	Louisville Bridge and Iron Co	Angle iron	5.96
	17	The Drummond Manufacturing Co.	Castings	22.68
	18	J. M. Osburn	Horse	200.00
	19	J. B. Speed & Co	Cement	57.96
	20	Standard Oil Co	Oil	44.03
	21	W. B. Belknap & Co	Supplies	11.63
	22	Imperial Laundry	Laundrying	1.37
	23	W. B. Belknap & Co	Steel, etc	36.69
	24	R. B. & G. W. Shaw	Inspecting and testing cement.	7.25
	25	W. W. Hite & Co. (Incorporated)	Pitch, etc	111.29
	26	Louisville Water Co	Water supply	37.34
	27	J. T. Duffy	Rent of office	126.80
	28	Guy Callender	Newspaper	1.95
	29	Frederick Diehl	Supplies	10.36
	30	Alexr. Harthill, jr	Horseshoeing	2.80
	31	Northern Lake Ice Co	Ice	38.94
	32	The Drummond Manufacturing Co.	Drill chuck, etc	8.03
	33	Stagg & Bacon	Filter	16.00
		Total expended		87,569.13

During the fiscal year the following collections have been made and deposited to the credit of the Treasurer of the United States:

For rent of land pertaining to the Louisville and Portland Canal	$285.00
For use of Louisville and Portland Canal dry dock	298.33
Total	583.33

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Allotments for operating and care of Louisville and Portland Canal since July 1, 1880, when tolls were abolished and the canal became a direct charge on the Treasury of the United States.

May 18, 1880 *	$127,000.00	July 13, 1893	$77,158.68
March 3, 1881 *	88,000.00	September 9, 1893	2,000.00
July, 1884 *	73,000.00	July 11, 1894	114,528.08
August 3, 1885	91,840.00	November 27, 1894	1,500.00
July 28, 1886	82,320.00	July 12, 1895	112,838.28
July 2, 1887	77,805.00	July 28, 1896	123,715.05
July 13, 1888	99,456.79	July 23, 1897	67,311.47
July 20, 1889	55,548.88		
July 17, 1891	78,769.38	Total	1,374,967.55
July 20, 1892	102,175.94		

REPORT OF MR. J. H. CASEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
LOUISVILLE AND PORTLAND CANAL,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations for operating and care of Louisville and Portland Canal during the fiscal year ending June 30, 1898:

REGULAR FORCE.

The canal was open to navigation three hundred and twenty-six days, and closed thirty-nine days on account of high water during the months of January, February, March, and April.

On January 26 the upper gauge read 30 feet and the lower gauge 55.6. The highest water during the year was in March, when the gauges read 36.3 and 62 feet, respectively. The lowest water occurred on September 30, 1897, the gauges reading 2.6 above and 2.5 below.

During locking stages the lock force passed boats through the canal with very little interruption. When not passing boats, they were employed about the locks and canal as follows: Completed the grouting of upper stone revetment, north side of canal, west of middle engine house, and grouted a portion of upper revetment on the south side, near lower engine house.

Removed south leaf of old lower gates, and hung new gate in its place; removed, painted, and stored away rigging that was used for the erection of gate; painted guard and upper gates at new locks with graphite paint; trimmed trees, removed dead trees and planted others in their places on lawn east of office, and trimmed hedge along south canal bank from Twenty-sixth street to Twenty-eighth Street Bridge; removed and straightened wicket stem and suspension rods at lock gates, repaired gate chains, and put in new front and back chains at middle gates, new locks; repaired gutters, and placed iron sheeting on roof of north middle engine house, which was damaged by high water.

The old wooden foundation timbers under drums at lower engine house, south side, were replaced with new ones, new cast-iron stands and six drums were placed in tunnel at middle gates, north and south side, and two at upper gates.

Repaired and overhauled electric-light wires about shops and locks, and lowered two poles at Twenty-eighth Street Bridge about 10 feet, which carries telephone and electric-light wires across canal; removed and reset poles on works; filled in washouts on south canal bank, and cut ditch on top of bank to prevent water from running over slopes; painted smokestacks; filled up engine pits in lock engine houses with concrete, to make engine bed plates solid; repaired steam pipes in engine houses; mowed slopes and lawn; washed mud from lock walls and engine houses, and cared for property during high waters.

*From act of this date; date of allotment not available.

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The following tables show amount of traffic and commerce passed through the canal and over falls during the year:

COMMERCIAL STATISTICS.

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1898.

Vessels.	Number.	Capacity.
		Tons.
Passenger boats	587	238,746
Towboats	879	112,703
Government boats	297	24,440
Coal boats and barges	2,851	790,771
Small craft	429	128
Total	5,043	1,166,788

Lockages, 2,212.

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1898.

Articles.	Tons.	Articles.	Tons.
Coal	852,449½	Hay	4,263½
Corn	371	Straw	2,755
Wheat	6,817	Cattle	5,147
Salt	5,863½	Lumber	47,527
Oil	865½	Staves and shingles	68,039½
Whisky	443½	Steel rails	27,098
Flour	849½	Iron ore and manufactured iron	13,369
Sugar	6,048½	Produce	3,935½
Molasses	4,070	General and miscellaneous	105,038
Cement	1,220½		
Tobacco	1,951½	Total	1,114,991½
Cotton	4,204½		

Number of passengers, 12,441.

Statement of commerce passing Falls of Ohio River, via Louisville and Portland Canal and Indiana Chute, from June 30, 1886, to June 30, 1898.

Articles.	From 1886 to 1897.	From 1897 to 1898.	Total for 12 years.
	Tons.	*Tons.*	*Tons.*
Coal	16,396,258½	1,354,386½	17,750,645
Salt	103,965½	6,498½	110,464½
Oil	55,989	1,115½	57,104½
Whisky	19,247½	528½	19,776½
Tobacco	78,983½	2,200	81,183½
Cotton	115,891½	6,108½	121,999½
Lumber	3,000,262½	48,739½	3,049,001½
Corn and wheat	114,104½	7,433	121,537½
Iron ore	311,314	13,404	324,718
Iron	132,005		132,005
Steel rails	459,395	42,443	501,838
Produce	73,988½	4,051½	78,040½
Hay and straw	167,724½	8,166½	175,891½
Flour	14,445	1,134½	15,579½
Stock	80,501½	5,937	86,438½
Sugar and molasses	88,388	13,370½	101,759½
Staves and shingles	385,829	22,669½	408,498½
Cement	34,005½	1,387½	85,392½
Miscellaneous	980,401	121,111	1,101,512
Total	22,612,699½	1,660,685	24,273,384½

Annual average during past 12 years, 2,022,782 tons

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Vessels passing Falls of Ohio River, via Louisville and Portland Canal and Indiana Chute, from June 30, 1881, to June 30, 1898.

Kind of vessels.	1881 to 1897.		1898.		Total for seventeen years.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.
Passenger boats	16,270	6,490,051	758	314,989	17,028	6,805,040
Towboats	18,344	2,448,773	1,313	194,834	19,657	2,643,607
Government boats	2,833	223,907	360	27,112	3,193	251,019
Coal boats and barges	65,461	20,869,144	3,784	1,088,673	69,245	21,957,817
Small craft	3,944	1,008	433	848	4,377	1,856
Rafts	70	2,577	.....	.....	70	2,577
Total	106,922	30,035,460	6,648	1,626,456	113,570	31,661,916

Annual average during the past seventeen years—boats, 6,680+; tons, 1,862,465+.

TOWBOAT.

The towboat *Major Mackenzie* was employed during the year in towing mud scows for dredges and from retaining wall dry dock; also towed barges, derrick boats, etc., for the different works as required.

On the morning of August 25, 1897, at 4.20 o'clock, left for Leavenworth, Ind., to tow two barges to canal locks; returned at 6.25 same day. From September 20 to 30 was laid up on account of placing new mud drums on boat to replace worn-out ones.

During the high water the steam tender *Wave Rock* kept drift out of head of canal with the *Mackenzie's* crew.

Owing to the great amount of dredging required at head of canal on improvements for Falls of Ohio River, the towboat and dredge *Louisville No. 1* commenced working day and night October 4, and continued to November 9, when it was necessary to discontinue on account of repairs to be made to the dredge; resumed night operations on December 20, and continued same to end of fiscal year when not prevented by high water.

DREDGES.

Dredge *Louisville No. 1* worked the entire year, except when laid up for repairs and high water, dredging in canal proper from Seventh street to lower entrance of canal; also dredged dirt from in front of north canal wall west of Fourteenth street; assisted in raising south leaf of lower gates.

Dredge *Wabash* was put in commission on November 13 and continued dredging throughout the year, working part of the time day and night.

Dredge *Louisville No. 2*, a combined hydraulic dredge and derrick boat, which was built at the canal, was put to work on February 2 at the lower entrance to locks, pumping the heavy deposit of mud left by the high water of January, and has continued working in the canal and on improvements for Falls of Ohio River with grapple, dredging large stone.

All of the dredges have lost considerable time on account of extensive repairs and the great quantity of coal passing through the canal.

During the month of January, 1898, dredges *Louisville No. 1* and *Wabash* were engaged entirely on the falls work. The dredges were towed to Twelve-Mile Island and Rock Island, where they dug sand for use on the different works when required. Amount of dredging done during the year was as follows:

	Cubic yards.
Mud removed from canal proper	103,795
Mud removed from in front on north canal wall, west of Fourteenth street	2,305
Sand dredged at Twelve-Mile Island	595
Sand dredged at Rock Island	100
Total	106,795

DRY DOCK.

On account of building the new south wall at dry dock, the dock has been available very little time for outside parties during docking stages of the river. It was occupied eighteen days eight and one-half hours by five boats, for which the collections amounted to $298.33. Twenty-seven Government boats used the dock one hundred and fifty eight days and three hours.

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MISCELLANEOUS, FUEL, OIL, ETC.

During the year nine barges of coal were purchased for use on canal and work at head of canal. Supplies, oil, etc., were purchased as required for making necessary repairs and maintenance of canal.

The 30-horsepower boiler which furnished steam for shop engine having been in use for many years, and which was more or less damaged by the fire which destroyed the machine shop in 1892, gave evidence of being unfit for much further service, and was replaced in April, 1898, with a new 40-horsepower tubular boiler of the Lidgerwood type, furnished by Messrs. Hegewald & Co., of New Albany, Ind. The work of tearing out the brick and removing the old boiler from the shop was done by hired labor. A portable boiler was set up on the outside of the building and connected to the engine in the shop while the new boiler was being built.

COMBINED DREDGE AND DERRICK BOAT.

This was built by hired labor on ways near the dry dock. The lumber was delivered on cars at Eighteenth street switch, from which place it was unloaded by means of a derrick boat onto barges and towed to shipyard at canal. On the 22d of November, 1897, a small force of carpenters commenced to cut timbers ready for framing, and on the 29th began assembling them together. On January 8th, 1898, the hull was completed and launched from ways into the dry dock. The blacksmith and machine forces made all of the ironwork for derrick, bolts, drifts, and chains used in constructing the hull and the placing and setting up of the machinery on boat ready for work.

On the 31st of January steam was raised and the pump tested. The working of the engine and pump was entirely satisfactory, the 15-inch discharge running completly full, with an average steam pressure of 70 pounds on the boiler.

One steel mast bull wheel, 12 feet in diameter, and one No. 2 mast turning winch were purchased from the American Hoist and Derrick Company, for use in operating the derrick. One 35-horsepower triple drum (9 by 10 inch cylinders and 14-inch drum) hoisting engine was purchased from the Lidgerwood Manufacturing Company, for operating the derrick and handling the suction pipe on boat.

The boat was placed in commission on February 2, 1898, and has been successfully operated in dredging with Lancaster grapple and pumping mud from the canal, dredging large rock with grapple from head of canal to June 30th.

This boat was fully described in my estimate of June, 1897.

Cost of dredge:	
Labor	$1,902.01
Material	2,674.01
Total	4,576.02

NEW HULL FOR DRILL BOAT.

This hull, 16 by 80 feet, is to replace a worn-out and condemned hull, which was sold at public auction December 21, 1897. The work of building the hull was done by hired labor in the shipyard near the dry dock. Owing to failure of lumber contractor to supply all of the timber at one time, the work was greatly retarded. All of the timbers required to be dressed were run through the planer, and the work of cutting out gunwales, etc., commenced in December, 1897. The hull was launched on April 30th and completed in May, 1898. On account of being short of barges for this season's work, a false deck was put on the hull and it will be used as a barge. The cabin will be placed on the hull during the ensuing year.

Cost of new hull:	
Labor	$734.08
Material	503.13
Total	1,237.21

ENLARGEMENT OF COAL BIN.

This enlargement is an extension of 81 feet to the coal bin completed in December, 1895, adding a capacity of 800 tons, which now gives a total capacity of 1,800 tons, or 45,000 bushels.

Commenced to build stone pedestals for sills to rest on in September and finished same in October, 1897. The contractor completed delivery of lumber on November 16, and the work of cutting timbers and getting same ready for framing was commenced on November 15, 1897. The carpenter work was completed in December, 1897, with the exception of coal chutes, which were put on in June, 1898. The coal bin is built

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of long-leaf yellow pine, the sides and roof being covered with corrugated iron. Coal shutes are fastened to south side of coal bin for convenience in unloading onto boats and barges.

The following is the amount of masonry and excavation for foundation:

Masonry in pedestals	cubic yards	176.93
Concrete for base of pedestals	do	24
Earth excavated for pedestals	do	180
Earth filled in under bin	do	465

Cost of extension to bin:

Labor	$1,520.39
Material	1,430.70
Total	2,951.09

TWO NEW DUMP SCOWS.

These scows are required for carrying mud, etc., removed from the canal by the dredges. A proposal was accepted November 2, 1897, from the Elizabeth Marine Ways Company, of Elizabeth, Pa., for the building of two 100-yard scows, 85 by 24 by 6 feet, built of white oak, and similar in design to those now in use on the canal, for the sum of $1,900 each, the scows to be delivered at Davis Island Dam. On account of bad weather and ice in the river the time for delivery was somewhat delayed. The scows were delivered to the McKinley Coal Company, at Davis Island Dam, February 12, 1898, who towed them to Louisville, Ky., arriving at the canal March 1.

Two inspection trips were made to Elizabeth, Pa., during the construction of the scows, and one to Davis Island Dam to receive same.

Cost of two dump scows:

Contract	$3,800.00
Towing	49.75
Inspection trips	104.83
Labor	27.34
Total	$3,981.92

DRY-DOCK GATES.

No work was done under this head on account of the retaining wall at dry dock not being completed. It is proposed to erect these gates during the coming year.

RETAINING WALL, DRY DOCK.

The Salem Bedford Stone Company completed the delivery of stone contracted for May 19, 1897, in September, 1897. All of this stone was delivered on the Eighteenth street switch, then towed to near the site of the wall, and stored on south canal bank.

Very little has been done on this wall on account of the many rises in the river and the continued high waters. On January 10 the stage of river permitted the draining of the dry dock, and work of excavating earth at south dry-dock pier was commenced and continued to the 15th, when work was suspended on account of a rising river. Work was again resumed on March 4 and continued to the 19th, when we had to flood the dock on account of high water.

Resumed work of excavating again on April 16 and continued to the 28th, when all of the earth down to the foundation for wall was removed for a distance of about 60 feet east of the double-faced dry-dock wall. On the afternoon of the 28th commenced to set stone and continued to the 30th at noon, when we again had to flood the dock on account of a rising river.

On May 4 the river receded sufficiently to permit removal of earth caved in from banks and washing deposit of mud left from high water, which was continued to the 7th, when high water again interfered with the work.

From the 17th to the 20th, while laying foundation course for new wall, the river again came up and compelled us to suspend operations to June 10, when the work of setting stone was again resumed and continued to June 30.

Amount of work done and cost of same is as follows:

Earth and rock excavated	cubic yards	1,800
Masonry built	do	333
Dry wall removed	do	25

Cost:

Labor	$534.95
Material	1,522.41
Total	2,057.36

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RETAINING WALL, UNPROTECTED BANK.

On account of the unfavorable stages of the river during the year, a very small portion of this wall was built. On August 7 commenced the earth excavation for foundation of wall west of coal bin, which connects with the pierhead at old locks. The earth excavated was dumped in the canal along the proposed wall, to form a dam to allow the setting of stone. On the 16th began setting stone and continued in August, when the wall was completed to elevation 50, canal gauge.

During August and September, 1897, for a distance of about 100 feet east of the coal bin, the earth and rock were cleaned from rock ledge preparatory to laying wall. The dredge boat dredged the earth that was utilized for a dam and filled in behind new wall with same. Some old stone which is to be used in building the wall was loaded on barges at head of canal and placed along the north canal bank, so as to be in readiness when required.

Amount of work done and cost of same is as follows:

Masonry laid in wall	cubic yards	389.18
Earth and rock excavated	do	1,062.00
Earth filled in behind wall	do	98.00
Cost:		
Labor		$1,418.26
Material		137.02
Total		1,555.28

AUTOMATIC GATES, DRY DOCK.

The concrete masonry piers, valves, and operating machinery were completed in the month of August. The proposal of the Sulzer-Vogt Machine Company, dated July 3, 1897, to furnish all labor and material necessary and construct and erect gate for the sum of $2,915.89, was accepted July 5. Shortly afterwards they commenced shop work of forging, drilling plates and angles, and in August commenced delivery and assembling and erecting gate, completing the same ready for trial October 23. On trial the gate was raised and lowered successfully four times. On examination it was found that the downstream leaf leaked and would not stand the required pressure. Also that the gate, when down, did not come to a proper bearing, owing to the rest on the lower half of the upstream leaf being 3 by 3 inches instead of 3 by 5 inches, as called for by the specifications. The gate was suspended to allow the contractor to raise the rest to the required height and complete the calking.

Trial was again made in November. The downstream leaf would not stand the required pressure, and five hinges in the fold of the upstream leaf were found broken, owing to their not being in good alignment. Owing to the inclemency of the weather and high water, work was suspended until the present month, when the work of washing out the mud and uncoupling the gate commenced. The gate is now ready for a thorough examination.

It is proposed to replace the seventeen bolts in the fold of the upstream leaf by one continuous bolt. In this manner we expect to have a perfect alignment and equally distributed bearing throughout the leaf. The gate will be in working order within the next month.

Cost of labor	$1,638.58
Cost of material	997.89
Total	2,636.47

EXTRA LABOR.

The expenditures under this heading were for tearing out old saw carriage and setting up new sawmill in planing mill; taking up tracks in mill and relaying same for conveying timbers to and from sawmill; making blue-print carriage for engineer office; taking up old plank walk from Twenty-sixth street station to Twenty-eighth Street Bridge, and putting down a walk of broken stone and screenings; cleaning roadways and spreading screenings on same by canal warehouse; extending after end of cabin on towboat *Major Mackenzie;* transferring ice box from cabin of towboat to lower deck, and making and placing in pilot house one light sash to take the place of old sash; taking down old iron columns at lower gates, old locks, and erecting same at guard gates, old locks, for suspending gates to allow the gates to be opened at low stages of the river; dismantled old drill-boat hull and placed boiler on wall, and fitted up same for steaming lumber; made tool house with old cabin of drill boat in corner of shipyard; trimmed hedge south side of canal bank; made stands for oil tanks in oil house; painted signs for hanging on ends of bridges, water

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gauges, iron cresting on top of lock engine house, and screens for office; made telephone booth in canal office; unloaded sand from barges on canal wall for use on works; made shelving for warehouse; washed mud from walls and revetments east of bridge after high waters; kept weeds pulled from revetment and grass mowed on slopes; dressed lumber in mill for different parts of the works; made hose butts for fire plugs, rack for hose alongside of warehouse, and cared for fleet during high water.

REPAIRS.

Repairs to boats this year have been quite extensive, owing to the dredges working the greater portion of the year night and day. The expenditures made for repairs to boats and about canal were as follows:

Towboat Major Mackenzie.—Replaced old mud drums with new ones; put in one light sash all around pilot house; made new cams for engines; took exhaust valves from both engines to machine shop, bored them out and placed new bushing and packing rings in same; replaced broken pillow blocks and pillow-block caps and lined up machinery; made new bucket planks and wheel arms when required; made new set of rudders, and repaired rudder bumpers and hog chains and painted deck.

On examining the steamer *Col. G. L. Gillespie*, it was found that the boat was letting down under her boilers. It was deemed necessary to put in a steel center longitudinal bulkhead, and three cross bulkheads, to replace wooden bulkheads. The work of boring beams, placing streaks in hull to receive bulkhead, tearing up floor and replacing same, and calking hull was done by hired labor. A contract was made with Messrs. Hegewald & Co., of New Albany, Ind., October 6, 1897, for placing steel bulkheads in hull and four new cast-iron flanges on wheel for the sum of $539.74. The contractors completed their work in October, 1897.

The expense of making these repairs was divided between the canal and Green River.

Dredge Louisville No. 1.—Completed new dipper and worked on repairs to old dipper; made new endless chains for sprocket on turntable, and new swinging chain for turntable; took out all loose rivets on crane and turntable and repaired same; put new flues in boiler; repaired broken spuds, spud shafts, and bearings, and put on one new dipper handle and seven new spuds; replaced decayed nosing on main deck with new timbers; made new piston and piston rods for pump; repaired boiler feeder and made new brass stuffing box for pump; repaired capstan and leaks in boiler when required.

Dredge Wabash.—Made patterns for spud-rack castings; replaced old wooden kevels with new ones; put in new afterhead block; repaired and straightened spud frames, and replaced the greater portion of decking and calked same all over; made one new dipper handle and lengthened one spud 6 feet; put new nose on dipper; made valve rings for pump, new friction pin for main engine, new shaft for top of crane, and new gland for piston; repaired leaks in boiler and replaced old fire box with new one.

On April 20, while dredging on rock ledge at Fourteenth street, a hole was knocked in the hull which caused the dredge to sink. With the assistance of towboat and dredge *Louisville*, the dredge was raised, and towed to dry dock where the hull was repaired. Again, on June 17, the hull was found to be in such bad condition that it was necessary to put the boat on dry dock. The bow for about 7 feet was so rotten that it was deemed advisable to cut all the rotten timbers out and replace the same with new. During the time these repairs were being made to the hull the machinery was thoroughly overhauled and repaired. The boat is now in good condition and will probably do for several years' service.

Dredge Louisville No. 2.—Put on new spud, and repaired broken spud and a spud which was pulled from its fastenings; overhauled and lined up engine and babbitted bearings; patched bedplate on swinging engine and put in additional hold-down bolts on engine; repaired friction and made new friction and break bands for hoisting engine.

Scows.—The mud scows were placed on dry dock at different times during the year and were repaired by putting in new hopper plank, gunwales, stanchions, head blocks, timber heads and rake planks to replace rotten timbers. All the scows were thoroughly calked; and cast-iron ratchets were put on rollers to replace broken ones.

Canal repairs.—All of the decayed weatherboarding on residence was replaced with new boards, and all loose plastering in residence taken off and replastered; four rooms, two halls, and ceilings were repapered; the residence and office were painted with two coats of paint; repaired picket fence around shops and residence, and wire fence on property lines south and west of locks; repaired and painted trestle between machine shop and planing mill and lined up shafting on same; repaired steam-hammer pipes in blacksmith shop, water pipes at Twenty-eighth Street Bridge, wicket stem bearings on middle gates, new locks, and old chain blocks at dry dock; replaced three worn-out cast-iron rollers under Eighteenth Street Bridge, and

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replaced check posts along south canal bank between Tenth and Twenty-eighth streets; repaired roadway from Twenty-sixth street station to Twenty-eighth Street Bridge, coal-bin dump cars, spring wagon, and put new set of wheels on lumber wagon; repaired and replaced roofs on lower engine houses which were removed from buildings on account of wind and high waters. These roofs were fastened to buildings with large hinges which will allow them to raise with the water in the future.

The middle engine house, south side canal, was damaged to the extent of having top course of stone on both ends of building and upper portion of two gables removed by high water; also corrugated iron roofing was somewhat damaged, which was all repaired, and buildings put in good condition; repaired stone revetment between middle and lower engine houses, north side canal, which was damaged by water; made new arm forgings and repaired grapple; repaired Sturtevant blower in machine shop, drawing table in office, washouts in roadway north of shops, and placed new sill under joist on plate-girder portion of Eighteenth Street Bridge.

WORK DONE AT CANAL ON ACCOUNT OF IMPROVING FALLS OF OHIO RIVER.

During the year considerable work was done at the shipyard and in shops of the canal owing to better facilities for doing work at this point.

In December, 1897, a steam tender 12 by 40 feet, barge bow and stern, was completed. The boat is fitted up with a 48 by 96 inch horizontal fire-box marine boiler and two 6 by 24 inch long-stroke engines, and is to be used in towing small barges, tools, etc., to and from the works. After a trial trip it was found that the boat would not steer in backing. She was placed on the dry dock and her lines changed so as to allow her to back water under her hull, which made a decided improvement in handling the boat.

Built seven 22-foot skiffs; made patterns for castings for dump cars, bored and planed dump-car castings in machine shop, made rollers for incline, and bored out cast-iron stands for same; made a new derrick. Placed two compressor boats on dry dock and put in additional fore-and-aft bulkheads, lengthened 8 spuds 10 feet each, and put on new cast-iron racks for spuds; raised sides of one barge 12 inches by placing new gunwales on each side, and stiffened boat by bolting upright pieces alongside of gunwales, and calked the barge all over; made two wooden floats—one, 49 by 4 feet; the other, 46 by 4 feet—to be used along the compressor boats to load drill holes from; reconstructed a barge into a derrick boat; made a new anchor, and unloaded seven barges of coal in coal elevator and on canal wall; made loading sticks and plugs for drill holes; repaired parts of steam drills and strengthened platform from which steam drills are operated on compressor boats by fastening fourteen wooden knees under platform to the hull of boats; commenced to build one office flatboat and three flats for use at Indiana Chute.

WRECKS IN CANAL.

The only wreck in the canal during the year occurred on the morning of February 22. The steamer *Mariner*, in bringing a tow of coal down the canal, ran one of her barges, containing 25,000 bushels of coal, on the rock ledge near Eleventh street. One end of the barge rested on the rock ledge, the other end sinking 60 feet from the south canal wall, which left room in the canal for barges to pass two abreast.

The coal and wrecked barge were removed with very little delay by the owners, W. H. Brown & Son, of Pittsburg, Pa.

Very respectfully, your obedient servant,

J. H. CASEY, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 3.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

The improvement of this river was first undertaken by the General Government pursuant to the project and estimate submitted by Maj. G. Weitzel, Corps of Engineers, January 4, 1872, and the appropriation of June 10, 1872. The project as submitted contemplated the improvement of the river from its mouth to Lafayette, Ind., and has never been

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revised or modified excepting so far as it was affected by the act of March 3, 1881, which separated the river into two sections, with Vincennes, Ind., as the dividing point, and since then funds have been appropriated specifically for each section. The only other modification consists of the following:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 24, 1890, from Capt. Edward Maguire, Corps of Engineers, giving results of preliminary examination of Wabash River from Terre Haute to Lafayette, with a view of removing obstructions of snags and bars and reestablishing the navigation of said river between these cities, made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Maguire reports that, in his opinion, the stretch of the Wabash River referred to is not worthy of improvement. Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division, coincides in this opinion, and the views of these officers are concurred in by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPT. EDW. MAGUIRE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., November 24, 1890.

GENERAL: In compliance with circular letter of September 20, 1890, I have to submit the following report, based upon a preliminary examination made under my direction by Assistant Engineer O. L. Petitdidier, of the Wabash River, Indiana, from Terre Haute to Lafayette, with a view of removing obstructions of snags and bars and reestablishing the navigation of said river between those cities.

The river between Terre Haute and Lafayette is approximately 107 miles in length, its normal width being about 300 to 350 feet in the upper half and 400 to 500 feet in the lower half of that reach. At the time of examination the stage of the river was about 8 inches above that of lowest water. In the upper 89 miles, which were passed over in a row boat, there were found to be twenty-nine sand and gravel bars. The depth over the majority of these bars was sufficient to permit of a boat drawing 12 inches being warped through the best channel, but in two or three cases a boat drawing 10 inches could hardly have been dragged through. The upper 50 miles of the reach were almost free from snags, but the latter increased rapidly in size and number below Big Pine Creek, the mouth of which is about 60 miles below Lafayette.

The stretch of river under consideration is also crossed by a number of county-road and railroad bridges unprovided with draws, or so located as to render navigation very difficult. At Attica, where three bridges are located near to each other, not only is navigation very difficult at any stage, but it is almost impracticable at low water, on account of the large quantities of riprap protecting the foundations of the piers.

The bridges between Lafayette and Terre Haute are 9 in number, located as follows: Three at Attica, 2 at Covington, 1 at Lodi, 1 at Montezuma, and 2 at Clinton. The first six mentioned are without draws, and the minimum clearance 30 feet 3 inches.

In addition to the above, the remains of the piers of a former bridge obstruct the channel 4 miles above Covington. At present there is one small boat which navigates the stream, and that one was at the time of the examination tied up at Terre Haute, waiting for a rise in the river.

The freight carried on the river is purely local and comparatively insignificant in amount and value. It consists of corn, wheat, staves, railroad ties, and some broken stone. The coal is carried by the railroad, which skirts the river for the whole distance under consideration.

In view of the above, my opinion is that the stretch of river referred to is not "worthy of improvement" for the following reasons:

1. Owing to the obstructions, due to bars and bridges, navigation at low water is impracticable; at medium stage only very small steamboats can navigate the river; at high water the bridges are complete obstructions to any navigation.

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2. The stream flows through an alluvial region and its banks are low and easily washed. Hence, any system of improvement looking to the production and maintenance of an unobstructed navigable channel would be so costly as to render it unworthy of consideration at present.

3. The result of careful inquiries does not lead to the anticipation of any important increase in commerce, and hence "the present and prospective demands of commerce" are too slight to be worthy of consideration.

Very respectfully, your obedient servant,

EDW. MAGUIRE,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through the Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., November 28, 1890.

Respectfully forwarded, with report that I concur in the views of Captain Maguire as herein expressed.

O. M. POE,
Colonel, Corps of Engineers, Division Engineer, Northwest Division.

The original project referred to above is as follows:

ORIGINAL PROJECT.

Little Chain:		
Snags and dredging	$3,000.00	
Excavating 47,371.24 cubic yards earth, at 25 cents	11,842.81	
Excavating 96,166.1 cubic yards earth, at 50 cents	48,083.05	
		$62,925.86
Grand Chain, 22,837.36 cubic yards rock excavation, at $1.25		28,546.70
Warwick's Ripple, 8,640 cubic yards excavation, at 30 cents		2,592.00
Towheads, below New Harmony, Ind., 2,963 cubic yards excavation, at 75 cents		2,222.25
New Harmony Cut-off:		
4 acres of land, at $25 per acre	$100.00	
8,546¼ cubic yards dam, at 75 cents per cubic yard	6,342.25	
		6,442.25
Coffee Island Chute:		
11,072.4928 cubic yards rock excavation, at $1.25	13,840.62	
343 cubic yards riprap, at $2 per cubic yard	686.00	
		14,526.62
White River Shoals, 3,120.824 cubic yards rock excavation, at $1.25 per cubic yard		3,901.03
Grand Rapids:		
917.88 cubic yards of excavation for foundation, at $1.50 per cubic yard	$1,376.32	
1,261.40125 cubic yards of foundation, at $8 per cubic yard	10,091.21	
8,000 cubic yards of wall masonry, at $10 per cubic yard	80,000.00	
2 sets gates, with machinery	15,000.00	
Removing old locks	3,532.48	
Repairing dam	25,000.00	
		135,000.01
Little Rock		500.00
Nine Mile Ripple, 3,700 cubic yards loose stone, at 75 cents		2,775.00
Horseshoe Bend, sand and gravel bar, 3,703 cubic yards, at $1.25		4,629.12
Swan Island, 4,629 cubic yards excavation, at $1.25		5,787.02
Dredging and snagging		14,400.00
		284,247.86
Add 10 per cent for superintendence and contingencies		28,424.78
Total		312,672.64

It will be observed that this project gives no specific channel width or depth. However, from the various projects submitted from time to time for the application of funds as they were appropriated, it is found that for the river below Vincennes a "navigable" channel 3½ or 4 feet

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deep was to be provided, while above that point a similar channel 3 feet in depth is desired.

Of the total amount ($355,000) appropriated to March 3, 1881, when the river was divided into two sections, $317,845.44 had been expended for improvements and $7,000 for the purchase of rights and titles held by the Wabash Navigation Company. Since that date an aggregate of $340,000, applicable to work below Vincennes, has been appropriated, of which, and the balance on hand March 3, 1881, $30,154.56, there has been expended for improvements at or in the vicinity of Graysville, Ill., the sum of $25,000, and $344,821.47 (including $25.75 outstanding liabilities) for a stone lock, wooden guide cribs, and an entirely new dam with stone abutment, and two fishways at Grand Rapids, and snagging and other general work at several points. The general dimensions and other data concerning the structures just mentioned are as follows:

	Feet.
Lock:	
Total length	214.5
Between miter sills	250
Spring of arch to head of lower recess	214
Width of lock chamber	52
Lift	11.5
Dam:	
Width at foundation	41
Width of sloping front measured horizontally	32.5
Width of sloping back measured horizontally	8.5
Fall of front	7.75
Fall of back	5.25
Total length of dam	1,095
Shore guide cribs:	
Length	150
Width	12
Height	15
River guide cribs:	
Length	121
Width, at point 8 feet, at lockhead	15
Height	15

Elevation above sea level.

High water, August, 1875	404.35
Low water (approximate)	376.92
Crest of dam	388.42
Top of upper miter sill	383.34
Top of lower miter sill	373.15

Since 1884 the greater portion of the funds for "below Vincennes" has been applied to the construction of the lock and its appurtenances. During these years the works on other parts of the river have deteriorated; some have been utterly destroyed, and others are worse obstructions than those they were designed to overcome. Thus, while the lock and dam have been completed and the former opened to navigation, it will be of little benefit to river traffic, since the remainder of the river is no longer navigable, even by ordinary sized boats, excepting at high stages of water, and then navigation is far from easy or safe.

The plan for the application of the funds last appropriated provided for the survey of the worst obstructed portions of the river below the lock. Accordingly, during the present year, an examination was made of the several points where improvements were formerly placed. This examination revealed the fact that the cut-off at New Harmony, Ind., was the worst and most effective obstruction to navigation on the lower reach of the river, and a careful instrumental survey of the locality was made for the purpose of aiding in the determination of what was necessary to reestablish a navigable channel at that point where the existing

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conditions are such as to practically cut in two the navigation of the river at normal stages of water. These conditions and the proposed remedy are set forth in detail in the following correspondence:

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., May 18, 1898.

GENERAL: I have the honor to submit herewith a report of a survey of the cut-off in the Wabash River, near the town of New Harmony, Ind., together with a map and profile showing the present condition of the river at that point, and location of banks and cut-off in 1883.

The survey was made pursuant to the provisions of my project of June 26, 1896, approved July 14, 1896, E. D. file $\frac{1818}{1818}$, for the expenditure of funds made available by the river and harbor act of June 3, 1896. This cut-off, located about 50 miles above the mouth of the river and 43 miles below the lock and dam at Grand Rapids, practically cuts low-water navigation on the river below the lock in two, and renders useless the permanent improvements at Grand Rapids and channel and bank work between that point and the cut-off.

The accompanying report I have carefully reviewed, after having had it prepared under my personal direction, and believe it suggests the most feasible, as well as the best and most economical manner of removing the difficulty. Therefore, it is respectfully recommended that the location, type and height of dam, and general features, as outlined in Mr. Shanks's report be adopted, leaving the minor details and methods of construction to be determined by the officer in charge, as the work progresses, provided funds are made available in the future for the improvement of the Wabash River.

In this connection I have the honor to invite attention to the fact that no comprehensive survey of the river has been made, excepting that made in 1881–1883, and extending from Terra Haute, Ind., to Mount Carmel, Ill.; from the mouth to Little Chain, 1877–1879, and local surveys at Little Chain, Grand Chain, Warwicks Ripple, Coffee Island Chute, and New Harmony at various times while work was in progress at those points. Nor has any comprehensive project for the improvement of the river been made, the only project of record in this office being the estimate submitted by Maj. G. Weitzel, January 4, 1872, subsequently adopted and referred to as the general project. This, however, specifies no minimum width or depth of channel, but is limited to certain points where the need of work was apparent twenty-eight years ago.

It seems to me apparent that no further expenditures should be made for the improvement of the river until the cut-off at New Harmony, or rather the obstruction to navigation at that point, has been removed; and that it would be advisable, in case it is intended to continue the improvement, that a survey of the river from Mount Carmel, Ill., to the mouth should be made to determine what further improvements are necessary to obtain a specified minimum width and depth.

As stated in my annual report for the fiscal year 1896, the improvement of this river is carried on, since March 3, 1881, under two separate appropriations, one applicable only to work above Vincennes, Ind., and the other only to work below that place.

In view of the report submitted herewith, it appears that my recommendation, as contained in the annual report referred to above, "that future appropriations be made applicable to 'improving Wabash River, Indiana and Illinois,'" and generally available wherever most needed, should be adopted.

There can be no reasonable pretext for improving the upper portion of this river until the lower portion has been made available for purposes of navigation.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

LOUISVILLE, KY., *April 16, 1898.*

CAPTAIN: In compliance with your order of February 9 and your instructions of February 23, 1898, directing me to make an examination of that portion of the Wabash River near New Harmony, Ind., with a view of recommending means of closing the cut-off in the interest of navigation, I have the honor of submitting the following report:

The survey was commenced on the 17th of February and closed on the 7th of March, 1898. The transit and stadia were used for locating the points, and lines of level were run to ascertain the fall of the river and for the purpose of fixing bench marks for reference in checking up the work. Soundings were taken and borings

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for solid rock were made at all points supposed to be necessary. The stage of water was recorded three times a day during the entire time of the survey.

About half a mile below the New Harmony ferry landing is the head of the cut-off. From this point the Wabash River flows west and south, and by nearly parallel lines back to the foot of the cut-off, a distance of nearly 10 miles around the bend to the point where it connects with the foot of the cut-off, which is 2 miles south of the head, inclosing Ribeyres Island, on which there are about 3,500 acres in cultivation.

The cut-off appears to have been a very small stream at the time of the first settlement of this part of Indiana. In those early days a mill dam was built across the foot of the cut-off on a rock reef, through which the water had cut narrow channels or chutes, leaving many projections of hard rock of from 4 to 8 feet in height. These rocks are now known as "the old dam." The stream was then so small that in time of low water the miller employed men to scrape out the cut with shovels and hoes to enable him to get sufficient water to turn his wheel. The mill has long since disappeared.

The cut evidently widened with every freshet, but it does not appear to have received much attention until the year 1874, when it threatened to take the whole river through the new channel and thus destroy the navigation of the river at that point, because the "old dam" at the foot of the cut-off was then, and it is now, an impassable obstruction to low-water navigation through the new channel.

In 1875 the General Government let a contract for building a dam across the cut-off. The difficulties encountered on this work from the beginning until its final completion are described in the following extracts, taken from the annual report of Maj. Jared A. Smith, United States Engineer, the officer in charge for the year 1879. Under the head of "Dam across New Harmony Cut-off," he says:

"On the 1st of July, 1878, work was in progress closing a break which had been made the previous January in the work of 1876. An opening 24 feet wide still remained, besides completing the superstructure and a reenforcement of the entire work. The following paragraph from my last report is repeated here, viz:

"'The difficulty of closing this gap may be estimated when it is considered that the water has at no time been less than 9 feet deep, and so rapid that in rushing through the break its surface falls 2½ feet in the width of the dam. This work will be pushed rapidly, and it is confidently expected that the present summer will find it all completed in a thoroughly substantial manner.'

"The repair and reenforcement was entirely completed early in November, 1878."

After giving the details of cost, Major Smith continues:

"The total expense of the season's work at this point, including contingencies and superintendence, was $13,450.20.

"The same work at prices with which contractors failed to complete the work, or to do any part of it well, would have cost, excluding all superintendence and contingencies $13,999.80.

"The expense of an inspector and other contingencies on the part of the Government would increase the cost by contract at least $1,000, making the total about $15,000.

"The comparison may be approximated as follows:

"Cost of season's work on dam	$13,450.00
"What same would cost by contract	15,000.00
"Difference in favor of doing the work by hired labor	1,550.00

"The work by hired labor was done under far greater difficulties, and its quality is better beyond comparison.

"The dam as thus completed may be best described in connection with its history.

"Below New Harmony the main channel forms a large bend or oxbow, about 10 miles in length, the parts being connected by what is known as the Cut-off, about 2 miles in length. The Cut-off having five times the declivity of the main stream, a total given approximately at 8 feet, besides being more direct and over a rocky bottom, was gradually becoming the main channel. It not only destroyed all through navigation save in extremely high water, but it deprived the town of New Harmony of one of its best routes and only competing one for its extensive shipments.

"It is one of the finest agricultural sections in this country, and without the dam at New Harmony the farms adjacent to 14 miles of the river banks would be deprived of any convenient outlet for produce or inlet for supplies.

"On the 2d of June, 1875, a contract was made with Messrs. J. M. & R. B. Kerr for a dam across the Cut-off, including all necessary materials and labor. The length of the dam then required was 350 feet, the depth at low water 6 feet, and the work designed was to be of open timber cribs built up 'log house fashion,' 12 feet

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high and 12 feet wide. An embankment of earth was placed against the upper side of the crib work.

"The dam rested on a soft shale, one end being against the same material at the foot of a high bluff, the other end against the island bank, which was composed of a very sandy loam. The island bank was protected by a pavement on the graded slope with a footing of riprap below water.

"The work was commenced in September, 1875, but in November, 1876, was still incomplete.

"Owing to high water and their own incompetence the contractors had sustained constant losses, and the river for 25 miles below was strewn with fragments of their work. The contract was therefore annulled, and the work was completed January 17, 1877, by hired labor and open-purchase of material.

"Early in February, 1877, the water rose about 5 feet over the dam; the cribs next to the island gave way, and a channel was cut around the end of the remaining part, carrying away a portion of the island more than 200 feet wide and nearly 1,000 feet in length. The surface of the rock bottom having a dip toward the island, the cut was made to an average depth of 10 feet below extreme low water. The half acre of land below the end of the dam, which had been donated to the Government, was so washed that its location was in mid-channel, and the owner of the land refused to donate, sell, or give the use of any more land for the purpose of completing the dam in that locality, as he considered that it would inevitably result in a further destruction of his lands.

"To decide the question between the necessary repairs and the extension of the old work or the construction of a new one at some other point, a board of engineers, consisting of Maj. G. Weitzel, Maj. W. E. Merrill, and Maj. J. A. Smith, Corps of Engineers, assembled at Indianapolis June 19, 1877. After visiting the works the board adopted the recommendations of the officer in charge to prolong the dam across the break, to raise the end as high as the island bank, which was to be carefully protected by crib work and paving. This was completed during the ensuing season, the main portion of the gap being closed while the water to a depth of 7½ feet was rushing rapidly through the break.

"The old contract of 1876 was so badly done that I had no confidence in its strength, and therefore completed designs and procured some of the material for its reenforcement.

"The following extract from a report of Mr. Bateman, dated January 2, 1878, given in my last annual report, is repeated here, as it describes the situation at that time:

"'The clumsy construction, large size of and numerous gaps between the timbers, great spaces between the cribs, and the small amount of and careless packing of the stone contained in the cribs gave rise to serious apprehensions as to the ability of that part of the work to withstand its share of the pressure through the winter's floods or until the reenforcing them can be resumed. Nothing but the compactness of the earthwork above the cribs would appear to give any strength, and on that is the only reliance until spring.

"'Your instructions were to build a line of crib work below this part of the dam to strengthen it, but the height of the river since those instructions were received has prevented the accomplishment of that part of the work.'

"Two days after the above was written the work mentioned gave way, resulting in an opening 120 feet long, the closing of which has already been described. * * *

"In the month of January, 1879, the river rose sufficiently to float a large amount of drift, among which were many trunks of immense trees. A sudden fall of the water left its surface so low that the logs would not freely float over the dam, so that the protruding knots, limbs, and roots tore away some of the paving. Each opening thus made gave fresh opportunity for further injury, resulting in openings sufficient to admit ends of floating logs, which then swung around in the rapid water and become immense levers, by which some of the strongest timbers of the dam were broken like twigs. The injury was principally on the slope of the dam, and was entirely within the line followed by the drift.

"Although the damage was due to a combination of circumstances which could rarely occur and could not be foretold save as the result of a similar experience, I have thought best to secure the work against a possible recurrence of such injury.

"The work has not broken away and can be readily repaired. Its cross section will be modified and the roof will be covered with pine plank 3 inches in thickness. Designs of these modifications are shown.

"The auxiliary cribs above the dam, which were used during its construction, have been built up to a height of 6 feet above the level of the crest of the dam. Other new cribs have been added, making 10 in all, so located as to check the drift and retain it to fill the channel. The 10 cribs have been completed, save the covering of the tops."

Since the above report was written the New Harmony dam was repaired and maintained every year until 1884.

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In 1886 Major Stickney, Corps of Engineers, then in charge, reported as follows:

"My predecessor in his report about this work says:

"'This work was intended to close the chute at New Harmony to prevent the river from making a cut-off and confine the low water to the channel proper. The dam has required constant repairs since its construction, the tendency of the river being to cut around its root by constantly washing away the bank of the island on which it rests. It will require repairs each season until the chute becomes filled up.'

"No repairs were made last season (1885), and during the high water the river made a new cut some 300 feet wide around the root of the dam on the island side and some 300 feet from its abutment. This new cut discharged into the old cut-off some 425 feet below the dam, and at present probably about one-third of the water discharge of the Wabash River passes through it. The immediate consequence of the new cut-off has been to shoal up the 12 miles of previously good river around the island, rendering navigation very difficult, if not impossible, at low water. The channel through the cut-off is impracticable except at high water. The new cut-off ought to be closed with a low dam."

The same officer again reports in 1887:

"The cut around the end of the dam at New Harmony which was mentioned in last year's report has considerably increased in depth and width, and it is estimated that fully one-half of the discharge of the river passes through it. It has not been practicable to do any work at this point during the year on account of insufficiency of funds. When the work is once commenced it should be completed in one season, and it will cost not less than $25,000."

Mr. O. L. Petitdidier, assistant engineer, in his report to Major Stickney for the year 1887 upon the condition of the New Harmony dam, says:

"The effect of this drain (discharge through the cut-off) on the main river has been to lower the upper pool one-half mile above it some 8 inches and to cause the main river to become shallower every year, so that at low water it is impossible for boats to come up around the island and navigation from the month is suspended at the foot of the cut-off. Neither can boats ascend nor descend through the cut-off except at high water, as there is a fall from head of cut-off to foot of same of about 7 feet in 2 miles, most of which fall, or 4¼ feet of which, occurs in a very short distance over a natural rock dam, once used as a milldam, and located some three-eighths of a mile above foot of cut-off.

"Our various improvements around the island, which had been quite successful, have thus become useless, and a very rich section of river, 12 miles in length, is thus directly deprived of navigation, while indirectly the whole river suffers from the want of through navigation, as the boats in the lower Wabash leave the river as soon as the water is getting low."

The foregoing extracts from the official reports give the history and show the condition of this work at the close of the fiscal year ending June 30, 1887. Nothing has been done since.

The dam, having been relieved by the changed location of the cut-off, has become overgrown with willows and cottonwoods, sycamores, etc., along its entire length, including the shore protection and the boom cribs, which were built above the dam in what was then the channel of the cut-off. The exposed timbers in the cribbing are nearly all rotted away. Part of the crest logs and some of the more recent deckings are still in position, except where disturbed and forced out by the growth of the young trees.

The cut-off bank on the Indiana side, in line of the prolongation of the dam, has not been changed since last described by Major Stickney. It is now 322 feet from the end of the dam, but the width of the cut-off has increased by erosion, entirely from the island side, from 325 feet, as then reported, to 550 feet at present.

The bottom lands along the Wabash River between New Harmony and the head of the cut-off will average about 14 feet above low water. The freshet of August, 1875, overflowed them to a depth of 12 feet.

The soil exposed along the banks is soft, sandy loam or crumbling clay mixed with sand. It overlies gravel and sand at a level of about 4 feet above low water. At about 5 feet below the bottom of the river is a stratum of compactly cemented gravel, which was at first supposed to be rock, but the steel rods were driven through it into softer sand. Unmistakably solid rock was found under a number of points adjacent to the proposed new location at an average of about 35 feet below the surface of low water. In some of the borings along the head of the island a stratum of soft blue clay was found at a depth of about 10 feet below low water.

The cut-off on a stage of 7.91 feet above low water at the time of this survey has a fall of 4.34 feet in its entire length of 2 miles; 1.14 feet of this occurs in a length of 150 feet at the "old dam" at the foot of the cut-off.

The Wabash River, around the island at low water, discharges 7,887 cubic feet per second, while the cut-off discharges 16,571 cubic feet per second—more than two-thirds of the entire discharge of the river. This change in the condition has resulted in the formation of shoals, bars, and shallow pools around the island, so

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that the navigation of that part of the river is wholly impossible at low water. Some of the tenants on the island find it necessary to employ guards to prevent their cattle from straying across the river to the Illinois side.

It is believed that the present dam, which is now of no use, was built too high. Had it been lower and cared for after every freshet, the probabilities are that there would now be no obstruction to navigation at this point. Therefore, in view of the excessive increase in the first cost and the expensive maintenance of a dam built higher than is necessary to close the cut-off to more than a navigable stage of water around the island, it is respectfully recommended that—

The crest of the proposed new dam be placed at a height of 3 feet above extreme low water, thus permitting all in excess of the discharge due to that depth to be divided between the two channels. It is known that this height would provide navigable water around the island at a low stage. During high water a dam is not needed at all. A high dam at high water would be of no benefit to navigation. It would be a risk to the Government, an injury to the property along the banks, and a source of uneasiness to those responsible for its construction. A low dam is therefore recommended.

Location.—It is proposed to begin on the Indiana bank about 500 feet above the head of the cut-off, and thence in a circular curve of 920 feet radius across the head of the cut-off 800 feet to the head of the island and thence along the bank tangent to the curve, a distance of 400 feet, making a length of 1,200 feet, exclusive of the shore protections at both ends. The profile along this proposed location shows a depth of from 14 to 18 feet below low water for a distance of 650 feet from the Indiana bank at the point of beginning the curve. The current strikes this curve in a direction parallel with the tangent along the shore, and the changing direction of the dam causes the current at high water to become normal to the curve at a point near the head of the island.

At high water the proposed dam will be submerged 20 feet or more, and it is believed that it will then have little or no effect on the direction of the current, while at low water its alignment will serve as a guiding dike directly parallel with the old channel of the river.

The proposed change in locations is recommended for the following reasons:

1. It is the only location that can serve the purposes of dam and guiding dike to confine the low water to its natural channel.

2. Its cost will be much less than the prolongation of the present dam. If the chute were closed by this prolongation, the dam, 631 feet long, would have to be entirely rebuilt, extended through 322 feet of timbered land, and thence across the new channel 530 feet to the island bank, a total length of 1,483 feet; 283 feet longer and part of it deeper than the proposed new dam. Supposing that the cost of the extra depth, and the necessary excavation through the 322 feet of sandy loam, to be equal in value to the stone filling which might be taken out of the old cribbing, and then estimating the same cost per foot for both locations, there would be a difference of 283 feet at about $42 per foot, amounting to $11,886 in favor of the recommended location.

3. The prolongation would have to be anchored on the island side of the chute at nearly a right angle, at a point where the land is open, cleared and cultivated, and where the current of every freshet is rapidly cutting it away. The top of the bank at this point is 2 feet lower than the bank at the head of the cut-off island, where it is proposed to anchor the new dam in a direction parallel with the bank.

4. The remains of the present dam 2,200 feet below the line of the proposed new dam at the head of the island. This large pool of 2,200 feet long by about 600 feet wide, held by the prolongation of the dam, which is deeper than the one proposed, would be a threatening danger to the interests of the Government and a menace to the island property.

The advantages of the recommended location can be more readily understood by reference to the accompanying map.

Construction.—It is recommended that the dam be made with three rows of piling, tied together and filled with rock, sheeted on the upstream side, and protected in the deepest part of the river with rock dumped in on a slope of 1 to 1, from the bottom up to 12 feet below the top; and on the downstream side with brush and fascines loaded with rock and pinned down, sloping 1½ to 1 from the top of the dam to the bottom of the river, the abutments to be cribbed well back into the banks and the shores protected in the usual manner.

In the estimate, the quantity for the downstream slope is given and rated as if it were all rock, because the price of rock will cover the cost of the brush.

Four-fifths of the cost of this work is the item of rock filling. It is believed that it can be done for $2 per cubic yard, and perhaps much less under favorable conditions; but the uncertainty of transportation, even from convenient quarries, has caused that price to be submitted.

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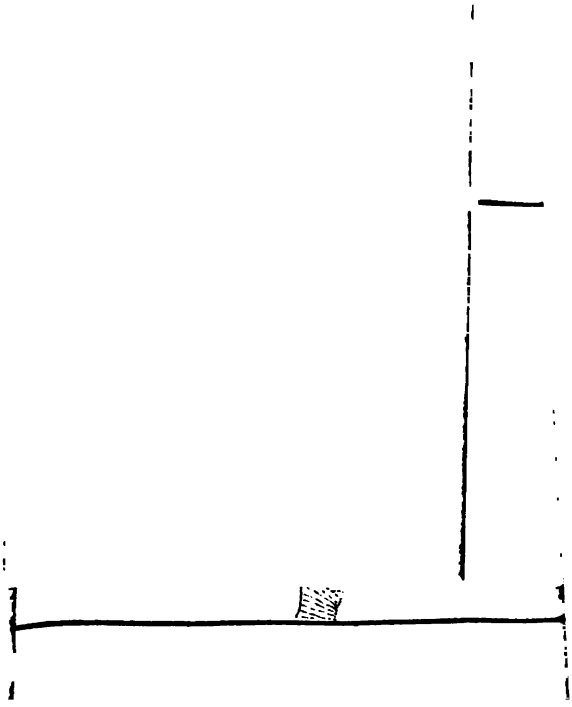

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Estimated cost.

Piling: 350 in place, average 30 feet long, 10,500 linear feet, at 25 cents		$2,625
Sheet piling: 1,200 feet on dam, 21 feet by 6 inches=151,200 feet, abutments and shore protection 150 feet by 16 feet by 6 inches=14,400 feet; total 165,600 feet B. M., at $16		1,350
Driving 1,350 pieces, at 30 cents		405
Waling: 2 lines (1,200 feet by 12 inches by 6 inches by 2)=14,400 feet, at $16		230
Cross ties on top, 1 for every 12 feet, 100 pieces, 19 feet by 8 inches by 12 inches=15,200 feet, at $16		244
Abutment cribs: 12 courses, 15 inches for stringer and tie, 48 pieces 25 feet by 12 inches by 12 inches=14,400 feet, 72 pieces 12 feet by 12 inches by 12 inches=10,368 feet; total 24,768 feet, at $16		396
Rock filling between the piles, cubic yards	10,364	
Downstream side slope 1½ to 1, bottom to top	6,207	
Upstream, against sheeting slope, 1 to 1, bottom to 12 feet below top	1,018	
Around abutments	444	
Shore protection	1,777	
	19,810	
Say 20,000 cubic yards, at $2		40,000
Excavation for shore protection, 2,500 cubic yards, at 20 cents		500
Labor, other than that included above, framing walings, cross ties, and abutment cribs, 220,000 feet B. M., at $7		1,541
Iron, bolts, nails, lines, etc		500
Contingencies		2,209
Total		50,000

Respectfully submitted.

THOMAS P. SHANKS, *Assistant Engineer.*

Capt. JAMES G. WARREN,
Corps of Engineers, U. S. A.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, May 27, 1898.

CAPTAIN: Your letter of the 18th instant, submitting report of the results of a survey of the cut-off in the Wabash River, near the town of New Harmony, Ind., and submitting project for closing the cut-off was duly received at this office with the following indorsement by the division engineer:

"[First indorsement.]

"UNITED STATES ENGINEER OFFICE,
"SOUTHWEST DIVISION,
"*New York, May 24, 1898.*

"Respectfully forwarded to the Chief of Engineers, United States Army.

"I concur in the recommendation made by the local officer that the location, type, and general features as outlined by Mr. Shanks's report be adopted, leaving the minor details and methods of construction to be determined by the officer in charge as the work progresses, provided funds are made available in the future for the improvement of the Wabash River. I also concur in his opinion that no further expenditures for the improvement of the Wabash (except at this cut-off near New Harmony) shall be made until a survey of the river below Mount Carmel is completed and a project approved for this entire improvement; also that the appropriations in future should be for 'Improving the Wabash River,' so that the money can be expended where it will be of service to commerce.

"HENRY M. ROBERT,
"*Colonel, Corps of Engineers, Division Engineer.*"

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The project submitted is approved, and it is requested that this subject be fully presented in your next annual report, together with your views respecting the necessity for a comprehensive survey of the river from Mount Carmel to its mouth, and recommendation regarding form of appropriation.

By command of Brig. Gen. Wilson:

Very respectfully, your obedient servant,

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

Capt. J. G. WARREN, *Corps of Engineers.*
(Through the Division Engineer, Southwest Division.)

[First Indorsement.]

UNITED STATES ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, May 28, 1898.

Respectfully forwarded to Capt. J. G. Warren, Corps of Engineers.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer, Southwest Division.

In addition to the foregoing it may be stated that if the improvement of the river is to be continued, a comprehensive and correct survey of the river is prerequisite to the preparation of an intelligent project and estimate for the systematic improvement of the river in such manner as to benefit and promote commerce. The old project, prepared nearly thirty years ago, bears no relation to existing conditions and should now be abrogated, and a new one, based upon requirements determined from the data furnished by the survey, substituted therefor. Such a project should provide that the work of improvement, other than snagging and dredging, be commenced at the mouth of the river and be carried upstream continually, and that the channel in the reach of river improved be kept open to the full specified width and depth by snagging and dredging whenever and wherever such obstructions appear. Commerce would then reap the full benefit of money expended, and in a short time boats could reach and pass the lock and the purpose for which it was built realized. Operations with such object in view would undoubtedly be beneficial, but it should be remembered that unless funds ample for rapidly pushing the construction work to completion are provided as needed the cost would be excessive. This also applies to the work at New Harmony and the proposed survey, to do which economically the full amount required for that structure and an additional amount of not less than $20,000 for the survey and contingencies, or $70,000 in all, should be made available at one time, or if appropriated in small sums, they should be held until their aggregate reaches that amount. After the survey has been made and the character and extent of improvements required determined and a project formulated, the yearly amount necessary to do the work proposed economically and advantageously can be stated more definitely than now and will depend in a great measure upon the quantity of improvement work required in a given reach of river, considered together with the snagging and dredging that conditions from time to time make necessary to maintain the improved channel at its full navigable width and depth during normal stages of water. The titles of appropriations for the work should be simply "*Improving Wabash River, Indiana and Illinois*," and should not specify or limit the funds to any particular place or locality, as the application can be more advantageously provided for in such plans as are called for and approved by the Chief of Engineers, United States Army, after each

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appropriation has been made and previous to the funds being made available for expenditure by the district officer in charge of the work.

In presenting the foregoing features the district officer desires to invite attention to the fact that after a careful study of the matter he is thoroughly convinced that the plan of improvement outlined above is the only one from which general benefits to commerce will be derived, since any method having in view the improvement of detached portions of the river will, as heretofore, be of local importance and benefit only, and with navigation cut in two make through lines of boats impossible. On the contrary, a continuous navigable channel would afford an outlet and a means of cheaper through transportation by the water route, which, if available throughout the year, would undoubtedly result in the establishment of through and regular lines of steamers, such as ply on other rivers in this district.

With reference to the present approved plan for the work at New Harmony Cut-off and the proposed survey, it is respectfully stated, in further explanation of the recommendation, that all of the funds for the purpose be made available at once, that as high water and ice gorges are of frequent occurrence in the river during the winter season, an incomplete structure of the kind proposed would either have to be protected at an unreasonable expense or suffer great damage, or possibly destruction. On the other hand, with sufficient funds to complete the structure in one good working season the danger and all unnecessary expense would be eliminated. For similar reasons of economy and advantage the survey should be commenced at the most favorable time and pushed to completion without break or delay.

The reports of operations, money statements, statistics, etc., for each section of river heretofore provided for follow under their respective headings.

IMPROVEMENTS BELOW VINCENNES.

Expenditures during the fiscal year ending June 30, 1898, were for the construction of the two guide cribs below the lock at Grand Rapids, filling and grading the grounds adjoining the lock, an examination of the river below Vincennes, and a survey of the cut-off at New Harmony, Ind., after which the available balance of funds being insufficient for further operations, all operations were suspended and the assistant's office at Mt. Carmel, Ill., closed.

Money statement.

July 1, 1897, balance unexpended	$7,168.91
June 30, 1898, amount expended during fiscal year	6,810.07
July 1, 1898, balance unexpended	358.84
July 1, 1898, outstanding liabilities	25.75
July 1, 1898, balance available	333.09

Amount (estimated) required for completion of existing project	*60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

*NOTE.—The estimated cost, $50,000, of the approved project for closing New Harmony Cut-off is included.

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Amounts and dates of appropriations.

June 10, 1872	$50,000	July 5, 1884	$30,000
March 3, 1873	50,000	August 5, 1886	60,000
June 23, 1874	25,000	August 11, 1888	60,000
March 3, 1875	40,000	September 19, 1890	60,000
August 14, 1876	70,000	July 13, 1892	60,000
June 18, 1878	50,000	August 18, 1894	15,000
March 3, 1879	20,000	June 3, 1896	15,000
June 14, 1880	25,000		
March 3, 1881	25,000	Total	695,000
August 2, 1882	40,000		

No contracts were in force at the end of the year.

IMPROVEMENTS ABOVE VINCENNES.

Expenditures during the fiscal year for this section were for a short period of snagging operations on the reach of river between Terre Haute and Vincennes. The work was done by a snag scow, which was towed to Terre Haute and worked downstream, by a crew consisting of a master laborer, hoisting engineer, cook, and 8 laborers.

Money statement.

July 1, 1897, balance unexpended	$2,212.61
June 30, 1898, amount expended during fiscal year	1,873.91
July 1, 1898, balance unexpended	338.70
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Amounts and dates of appropriations.

March 3, 1881	$25,000	July 13, 1892	$5,000
August 2, 1882	30,000	August 18, 1894	5,000
July 5, 1884	10,000	June 3, 1896	6,000
August 11, 1888	5,000		
September 19, 1890	5,500	Total	91,500

No contracts were in force at the end of the year.

List of steamboats plying on Wabash River, with a statement of the quantity of freight carried by each during the year ending June 30, 1898.

Name of boat.	Size.	Tonnage.	Tons of freight handled.
Alfred D. Owen	76 feet by 20 feet by 3 feet 2 inches	50	a 320
Hester (gasoline boat)		25	1,070
Herbert Moran	100 feet by 18 feet by 4 feet	56	3,335
D. A. Nisbet	125 feet by 24 feet by 2 feet 9 inches	65	7,665
Irene	77.5 feet by 18 feet by 2 feet 8 inches	27.07	3,374
Iowa	126 feet by 20 feet by 4 feet	96	2,800
J. F. Buckham	90 feet by 18 feet by 2 feet	93	325
Jessie Wilson	80 feet by 20 feet by 3 feet	76.70	a 320
Lucien Blair	67 feet by 14 feet by 2 feet	25	168
Jack Osborn		50	1,525
Nelly Chadwick	65 feet by 18 feet by 2½ feet	29.16	280
Owensboro	81 feet by 18 feet by 2 feet	35.29	4,524
Peter J. Clark	84 feet by 22 feet by 3 feet	54.48	446
The Racket	97 feet by 20 feet	58.50	1,500
R. Dunbar	160 feet by 29 feet by 4 feet	287	60
Total		1,028.20	27,712

a Approximated.

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In addition to the above—

The steamer *Irene* carried	1,116 passengers.
The steamer *Owensboro* carried	2,822 passengers.
The steamer *Peter J. Clark* carried	200 passengers.
Total	4,138 passengers.

The above list is not complete, but contains all the information that could be obtained. None of the boats made a through trip. The traffic was done principally between points below New Harmony, Ind., and on the higher stages of water.

E E 4.

OPERATING AND CARE OF LOCK AND DAM AT GRAND RAPIDS, WABASH RIVER.

The estimate and project for the operation and care of this lock and dam during the fiscal year ending June 30, 1898, contained the following items:

Salary of lock tender	$420.00
Repairs, extra labor, and miscellaneous	970.00
Contingencies	400.00
Total	1,790.00

Expenditures during the year were for the salary of the lock tender, repairing and repainting the lock gates, filling washout in lock grounds, minor repairs to buildings, and for oil for signal lights.

Following are the details of expenditures:

Detailed statement of expenditures made in connection with the work of operating and care of the lock and dam at Grand Rapids, Wabash River, during the fiscal year ending June 30, 1898.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	1	James Brown	Services	$35.00
August	1	Pay roll	do	39.80
September	1	do	do	69.80
	2	Peaslee-Gaulbert Co	Oil	5.59
October	1	Pay roll	Services	36.00
November	1	do	do	60.60
	2	Peaslee-Gaulbert Co	Union lead, etc	14.73
	3	Frank Tardy	Oakum, etc	4.73
December	1	Pay roll	Services	47.50
	2	C. H. Koster	Flag	4.10
1898.				
January	1	James Brown	Services	35.00
February	1	do	do	35.00
	2	F. C. Nunemacher	Blank book	3.50
March	1	James Brown	Services	35.00
April	1	do	do	35.00
May	1	do	do	35.00
June	1	do	do	35.00
	2	Frank Tardy	Supplies	7.80
		Total expended		539.15

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Statement of traffic and commerce through the lock at Grand Rapids, Wabash River, for the year ending June 30, 1898.

TRAFFIC.

Kind of boat.	Number.	Tonnage.
Passenger	10	270.70
Tow	36	1,141.25
Government	12	225
Barges	64	4,479.28
House	17	135
Small craft	182	205
Rafts	31	722
Total	352	7,178.23
Passengers	2,979	.....
Lockages	228	.....

COMMERCE.

Articles.	Tons.
1,200 bushels wheat	40.80
5,975 bushels corn	202.80
496,413 feet B. M. lumber	1,241
134 cubic yards stone	167
Total	1,651.6

E E 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

No operations were in progress during the year. For a full report of existing project see page 2244, Report of the Chief of Engineers for the fiscal year ending June 30, 1896.

For report of the resurvey of the river, made in compliance with the act of August 17, 1894, see pages 2483–2504, Report of the Chief of Engineers for fiscal year ending June 30, 1897.

Money statement.

July 1, 1897, balance unexpended	$811.74
June 30, 1898, amount expended during fiscal year	107.92
July 1, 1898, balance unexpended	703.82

Appropriations.

March 3, 1879	$25,000
June 14, 1880	20,000
March 3, 1881	20,000
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	7,500
August 11, 1888	5,000
July 13, 1892	5,000
August 18, 1894	5,000
June 3, 1896	2,500
Total	120,000

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E E 6.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

No work was in progress during the fiscal year. Full report of project and list of appropriations will be found on pages 2265 and 2266, Report of the Chief of Engineers for fiscal year ending June 30, 1896.

Money statement.

July 1, 1897, balance unexpended	$431.52
July 1, 1898, balance unexpended	431.52

E E 7.

RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY, KENTUCKY.

Report of project for this work will be found on page 2266, Report of the Chief of Engineers, for the fiscal year ending June 30, 1896. No operations under this appropriation were in progress during the year. The only work remaining to be done comprises the construction of guide cribs above the new lock and the completion of the grading and filling back of the land wall of the lock. It is proposed to do this work during the ensuing fiscal year at the same time the dam is being reconstructed. It is believed that the funds on hand are sufficient for the work remaining to be done and no further appropriation necessary.

Money statement.

July 1, 1897, balance unexpended	$9,920.26
July 1, 1898, balance unexpended	9,920.26

Appropriations.

March 3, 1893	$65,000
August 18, 1894	105,000
Total	170,000

E E 8.

IMPROVEMENT OF GREEN RIVER, KENTUCKY, ABOVE MOUTH OF BIG BARREN RIVER (LOCK NO. 5).

The final report and project, dated August 11, 1891, page 2481, Report of Chief of Engineers, United States Army, 1891, for the improvement of this portion of Green River, Kentucky, provides for the extension of slack-water navigation about 47½ miles above the junction of Green and Barren Rivers, or to Mammoth Cave, Kentucky, by the construction of two locks and dams, each lock having a chamber 36 feet wide and 161 feet long between hollow quoins, the combined lift

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of both aggregating 27 feet. The original estimate of cost of each of these locks is as follows:

Masonry in place, cement and labor included:	
Dressed face stone, 1,362 cubic yards, at $16.55	$22,541.10
Quarry face stone, 1,718 cubic yards, at $13.75	23,622.50
Backing stone, 4,291 cubic yards, at $8.70	37,331.70
Coping stone, 250 cubic yards, at $20.75	5,187.50
Special stone, 96 cubic yards, at $18.65	1,790.40
Cost of masonry	90,473.20
Two upper and two lower gates	4,000.00
Cofferdam and excavation	6,000.00
Dam complete	40,000.00
Abutment	5,000.00
Guide walls	10,000.00
Two lock houses, at $1,600 each	3,200.00
Engineering and contingencies	12,000.00
Foundation	10,000.00
Estimated cost of one lock and dam	180,673.20

Thus making the total estimated cost of improving the portion of the river included within the limits of the original report and project $361,346.40.

The first funds for the work was provided in the river and harbor act of July 13, 1892, in the following items:

Improving Green River, Kentucky, above the mouth of Big Barren River, for Lock Number Five, according to report and recommendation of Major D. W. Lockwood, Corps of Engineers, United States Army, submitted August eleventh, eighteen hundred and ninety-one, fifty thousand dollars.

The surveys for the site of the proposed lock were commenced during the autumn of 1892 (see page 2608, Annual Report, Chief of Engineers, 1893, and page 1971, Annual Report, Chief of Engineers, 1894), but no decision was reached until the site below the mouth of Bear Creek was surveyed and developed and a board of officers of the Corps of Engineers in their report, dated August 4, 1894, favored that location, which was approved by the Chief of Engineers.

Much delay was experienced in obtaining proper title to the land necessary for the lock site and lock tenders' cottages, abutment for dam, and roadway, on account of imperfect records of previous transfers and ownership. However, it can now be reported that these matters have been prosecuted to a satisfactory conclusion. The land on the lock side of the river has been purchased and paid for and the deeds therefor recorded. The land on the abutment side was obtained through condemnation proceedings in the United States courts, and payment therefor has been made to the clerk of the United States court at Louisville, Ky.

Under date of February 27, 1897, the Chief of Engineers, United States Army, approved the recommendation that the lock and abutment be built of concrete instead of stone. This change was made in the interests of economy, since it was estimated that the concrete in place would cost not to exceed $9.50 per cubic yard, whereas the estimated average cost per cubic yard for stone in place was $11.72, which amount, while it would be ample for work located at a point having direct means of transportation, was not considered sufficient for stone for this lock, which is located about 15 miles from any railway and about 180 miles above the mouth of the stream in the Ohio, and as there is no stone suitable for lock construction in the vicinity of the lock site, and if purchased elsewhere it would have had to be transported partly by rail

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and partly by water, necessitating rehandling, which would have greatly increased the cost.

The detailed estimate of cost of constructing the lock, dam, and appurtenances as contemplated in present approved drawings and plans was as follows:

LOCK.

Excavation:	
6,850 cubic yards above water, at 22 cents per cubic yard	$1,507.00
7,000 cubic yards under water, at 40 cents per cubic yard	2,800.00
9,000 cubic yards grading and resoiling, at 20 cents per cubic yard	1,800.00
Total excavation	6,107.00
Cofferdam for lock:	
85,000 feet B. M. gum timber, at $25 per 1,000 feet B. M	2,125.00
50,000 feet B. M. oak timber, at $30 per 1,000 feet B. M	1,500.00
8,000 feet B. M. poplar timber, at $25 per 1,000 feet B. M	200.00
8,300 pounds drift bolts, at 3 cents per pound	249.00
5,000 cubic yards puddle, at 20 cents per cubic yard	1,000.00
Total cost of cofferdam	5,074.00
Foundation for lock:	
12,730 linear feet piling, at 30 cents per foot	3,819.00
41,000 feet B. M. caps, at $30 per 1,000 feet B. M	1,230.00
131,000 feet B. M. flooring, at $32 per 1,000 feet B. M	4,192.00
46,000 feet B. M. sheet piling, at $32 per 1,000 feet B. M	1,472.00
23,000 pounds bolts, spikes, and nails, at 3 cents per pound	690.00
8,000 square feet building paper, at ½ cent per square foot	10.00
Total cost of foundation	11,413.00
Lock masonry:	
2,903 cubic yards in land wall.	
2,884 cubic yards in river wall.	
279 cubic yards in head and miter walls.	
6,066 cubic yards in concrete, at $9.50 per cubic yard	57,627.00
1,000 cubic yards paving, at $5 per cubic yard	5,000.00
Total cost of masonry	62,627.00
Gates, wickets, etc.:	
Gate and valve irons	4,000.00
Timber for gates and miters	1,300.00
Paint for iron and wood	30.00
Labor, framing, and erecting	700.00
Total	6,030.00
Auxiliary dams for lock:	
18,000 feet B. M. timber for two dams at upper and lower ends, at $30	540.00
Guide cribs:	
10,000 cubic yards excavation for 2 land cribs, at 30 cents per cubic yard	3,000.00
Piling, timber, and stone in place for 2 land cribs, at $6,000 each	12,000.00
8,000 cubic yards grading and resoiling, at 20 cents per cubic yard	1,600.00
Piling and timber and stone in place for 2 river cribs, at $3,000	6,000.00
Total cost guide cribs	22,600.00

DAM (285 FEET LONG).

2,088 cubic yards excavation, at 40 cents per cubic yard	$835.20
6,084 linear feet piling, at 30 cents per foot	1,825.20
100,224 feet B. M. sheet piling on upper face, at $32 per 1,000 feet B. M	3,207.17
76,032 feet B. M. sheet piling on lower face, at $32 per 1,000 feet B. M	2,433.02
14,400 feet B. M. caps, at $30	432.00
28,800 feet B. M. wales, at $30	864.00
115,200 feet B. M. sheeting, at $30	3,456.00
9,814 cubic yards stone filling, at $1 per cubic yard	9,814.00
3,456 cubic yards puddle, at 20 cents per cubic yard	691.20
Total cost of dam	23,557.79

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ABUTMENT.

Excavation, grading, resoiling:	
4,400 cubic yards excavation, at 22 cents per cubic yard	$968.00
3,500 cubic yards grading and resoiling, at 20 cents per cubic yard	700.00
Total	1,668.00
Foundation:	
900 linear feet piling, at 30 cents per linear foot	270.00
32,000 feet B. M. white-oak timber, at $30 per 1,000 feet B. M.	960.00
Total	1,230.00
Masonry:	
690 cubic yards concrete masonry, at $10 per cubic yard	6,900.00
1,000 cubic yards riprap, at $1.25 per cubic yard	1,250.00
400 cubic yards paving, at $5 per cubic yard	2,000.00
Total	10,150.00

BUILDINGS.

Temporary:	
Office	200.00
Cement sheds	1,000.00
Blacksmith and carpenter shop	100.00
Storehouse	50.00
Tool house	25.00
Oil house	20.00
Powder house	10.00
Dining room, kitchen, and barracks	600.00
Total cost temporary buildings	2,005.00
Permanent:	
One lock-tender's dwelling	1,800.00
One lock-tender's dwelling	1,400.00
Fencing grounds	200.00
Total	3,400.00

MISCELLANEOUS.

Excavating channel and approaches to lock:	
5,059.6 cubic yards, at 40 cents per cubic yard	2,023.84
Land for lock site, etc.	217.77
Fees, etc	104.94
Land, fees, etc., for abutment	500.00
Total	2,846.55

SUMMARY.

Lock	$91,791.00
Guide cribs	22,600.00
Dam	23,557.79
Abutment	13,048.00
Buildings	5,405.00
Miscellaneous	2,846.55
	159,248.34
Engineering and contingent expenses, 10 per cent	15,924.84
	175,173.18
Snagging and clearing banks, Lock 5 to Lock 6	5,000.00
Total	180,173.18

This statement is presented here merely to show the details of the estimated expense of construction of this lock with concrete instead of stone, and is in no way intended as a revision of the original estimate, but rather as an explanation of the modification of detail, which indicates no additional expense in connection with that estimate.

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At the beginning of the fiscal year the sum of $72,860.49 was available and the work of excavating for the foundation of the lock well under way, and arrangements for the cement, gravel, timber, hollow quoins, and minor items of material, supplies, tools, etc., necessary for the working season completed.

The broken stone for concrete and other purposes was obtained from a quarry, leased for that purpose, in the vicinity of the lock.

The construction work continued without intermission until December 31, 1898, when the land wall of the lock was completed and work suspended on account of inclement weather and lack of funds sufficient to resume operations during the calendar year 1898. The details of the season's work are given in the report of Mr. William M. Hall, assistant engineer, submitted herewith.

The work remaining to be done at this lock consists of the construction of the river wall of the lock, the abutment for the dam, the dam, gates, and wickets, clearing approaches, and an additional lock-tender's cottage.

The pool above the lock will have to be cleared of overhanging trees, snags, and similar obstructions, including some large bowlders, but by the terms of the act making appropriation it has been decided that the present funds are to be applied to the construction of Lock No. 5 and are not available for removing obstructions in the pools. (See E. D. file No. $\frac{187}{1}$, July 11, 1896.) As the lock can be of no benefit unless boats can navigate there, it is earnestly recommended that future appropriations be so worded as to permit of the necessary work in the pool being done. This could be easily accomplished by making the appropriation title read: "Improving Green River, Kentucky, above mouth of Big Barren, continuing improvement;" or, if it be the intention of Congress to defer indefinitely further appropriations or to limit improvements to the construction of Lock 5 and the pool above it, then it is recommended that the balance now on hand be made available for clearing the pool above the lock, which work can be done most economically and advantageously before the lock and dam have been completed and the depth of water increased.

Money statement.

July 1, 1897, balance unexpended	$78,450.95
June 30, 1898, amount expended during fiscal year	64,845.21
July 1, 1898, balance unexpended	13,605.74
July 1, 1898, outstanding liabilities	158.17
July 1, 1898, balance available	13,447.57
Amount (estimated) required for completion of existing project	85,673.20
Amount that can be profitably expended in fiscal year ending June 30, 1900	85,673.20
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

July 13, 1892	$50,000
August 18, 1894	25,000
June 3, 1896	20,000
Total	95,000

No contracts were in force at the end of the fiscal year.

NOTE.—For list of boats plying on Green River, and commercial statistics, see report for "Operating and care, etc., Green and Barren rivers, Kentucky."

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REPORT OF MR. WILLIAM M. HALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report upon the improvement of Green River, Kentucky, above the mouth of Big Barren River (Lock No. 5) for the fiscal year ending June 30, 1898:

As stated in my last annual report, that part of plant used in construction of the lock and dam in Rough River, Kentucky, and which was released after the completion of that lock, was moved and stored at site of proposed Lock No. 5, Green River, in December, 1896.

At the beginning of the fiscal year 1897, the amount of money available for Lock No. 5 was $88,459.05. It was therefore deemed advisable to only attempt during the season of 1897 and 1898 work which may be briefly stated as follows: Construct lockmaster's dwelling; make the excavation for (about 23,000 cubic yards) and build the cofferdam requisite for putting in lock foundation; construct pile and timber foundation for lock; erect land wall and place fill behind same.

At the beginning of the fiscal year arrangements had been made for the purchase of nearly all the tools, materials, etc., necessary for the season's work, and, as indicated in my report of June 30, 1897, the work was well started at that time.

Although progress was much delayed by slow deliveries of materials, etc., all the work undertaken for the season was satisfactorily accomplished. The quantities of work done are shown in detail in the table following:

TABLE No. 1.

Class of work.	Prior to June 30, 1897.	Subsequent to June 30, 1897.	Total.
Lock-master's dwelling	1	.....	1
Cistern for lock-master's dwelling	1	.....	1
Coal and wood sheds	1	.....	1
Closets, double	1	.....	1
Fencing grounds, linear feet	1,700	.....	1,700
Grading grounds, cubic yards	2,100	263	2,363
Shade trees transplanted, number	.....	54	54
18-inch drainpipe laid, linear feet	.....	30	30
6-inch drainpipe laid, do	.....	100	100
Excavation for lock:			
By dredge, clay, cubic yards	3,150	19,500	21,650
By dredge, snags, number	20	78	98
By pick and shovel above water, cubic yards	478	1,340	1,818
By pick and shovel below water, do	.....	3,485	3,485
Cofferdam:			
Gum timber, feet B. M.	.....	107,982	107,982
Iron, pounds	.....	4,500	4,500
286 triple-lap 6-inch by 12-inch by 20-foot white-oak sheet piles, feet B. M.	.....	37,752	37,752
Iron in sheet piles, pounds	.....	1,068	1,068
Puddle, cubic yards	.....	10,790	10,790
Excavation for puddle from site of dam by dredge, clay, do	.....	1,600	1,600
Excavation for puddle from site of dam by picks and shovels, do	.....	940	940
Lock foundation:			
White oak bearing piles, number	.....	704	704
White oak caps, 6 inches by 12 inches, feet B. M.	.....	40,020	40,020
Iron bolts (1,936), pounds	.....	10,380	10,380
338 triple-lap 9-inch by 12-inch by 12-foot 6-inch white-oak sheet piles, feet B. M.	.....	38,025	38,025
Iron in sheet piles, pounds	.....	1,992	1,992
Floor, double, 4-inch by 10-inch white oak, feet B. M.	.....	130,921	130,921
Iron in floor, pounds	.....	11,913	11,913
Concrete, mixed and placed, cubic yards	.....	3,141	3,141
24-inch vitrified culvert pipe, linear feet	.....	156	156
2 sets of iron hollow quoins, upper and lower, pounds	.....	10,840	10,840
Fill back of land wall:			
Clay, cubic yards	.....	7,085	7,085
12-inch vitrified pipe, linear feet	.....	143	143
Broken stone, cubic yards	.....	75	75
Drainage of grounds:			
24-inch culvert pipe, laid, linear feet	.....	337½	337½
18-inch culvert pipe, laid, do	.....	72½	72½
Excavating and refilling trench, cubic yards	.....	177	177
Guide cribs:			
Gum timber, feet B. M.	.....	11,855	11,855

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TABLE NO. 2.

	Expenditures from June 30 to December 31, 1897.			Expenditures to June 30, 1897.	Total expenditures.	Value of material on hand.	Cost of work done to date.
	Materials, etc.	Labor.	Total.				
Lock-master's dwelling	.....	.....	.....	$2,468.67	$2,468.67	.....	$2,468.67
Cistern to lock-master's dwelling	$3.52	.....	$3.52	98.33	101.85	.....	101.85
Coal shed and closet	.....	.....	.....	221.25	221.25	.....	221.25
Grading and improving grounds	.80	$42.20	43.00	207.85	250.85	.....	250.85
Grading yard, laying tracks, etc	.....	428.85	428.85	586.50	1,015.35	.....	1,015.35
Excavating for lock by dredge	223.49	3,275.96	3,499.45	305.60	3,805.05	.....	3,805.05
Excavating for lock by picks and shovels	.....	1,434.63	1,434.63	136.75	1,571.38	.....	1,571.38
Cofferdam about lock	1,434.47	1,950.61	3,385.08	1,844.24	5,229.32	$249.00	4,980.32
Timber and pile foundation for lock	6,239.10	4,115.89	10,354.99	259.04	10,614.03	307.92	10,306.11
Concrete masonry	14,875.06	8,391.35	23,266.41	789.57	24,055.98	1,039.72	23,016.26
Concrete forms	4,063.48	3,028.70	7,092.18	.....	7,092.18	3,047.61	4,044.57
Hollow quoins, etc	377.29	.....	377.29	.....	377.29	188.65	188.64
Filling back of land wall	68.34	1,000.00	1,068.34	.....	1,068.34	.....	1,068.34
Drain back of land wall	2.63	100.00	102.63	.....	102.63	.....	102.63
Drainage of grounds	.....	.....	.....	697.55	697.55	.....	697.55
Excavation for upper land-guide crib	.....	836.05	836.05	.....	836.05	.....	836.05
Erection of upper land-guide crib	81.80	15.20	97.00	.....	97.00	.....	97.00
Excavation for lower land-guide crib	.....	7.00	7.00	.....	7.00	.....	7.00
Erection of lower land-guide crib	87.14	16.20	103.34	.....	103.34	.....	103.34
Removing plant from Rough River Lock to Lock No. 5, Green River	.....	.....	.....	559.80	559.80	.....	559.80
Preparing plans and advertisements	.....	.....	.....	700.00	700.00	.....	700.00
Erecting temporary buildings	145.06	305.17	450.23	1,193.31	1,643.54	.....	1,643.54
Erecting plant, etc	.....	252.07	252.07	362.78	614.85	.....	614.85
Wharf, wharf trestle, trestle to yard, etc	9.25	138.80	148.05	547.71	695.76	29.00	666.76
Dredging for wharf	.....	.....	.....	87.96	87.96	.....	87.96
Unloading, storing, and inspecting material	.....	560.95	560.95	1,132.09	1,693.04	.....	1,693.04
Repairing tools and plant	10.95	826.45	837.40	91.60	929.00	.....	929.00
Miscellaneous—on account of lock	613.18	.....	613.18	959.06	1,572.24	.....	1,572.24
Tools	424.32	.....	424.32	.....	424.32	339.46	84.86
Machinery, etc	611.21	.....	611.21	.....	611.21	550.09	61.12
Watching plant	.....	.....	.....	309.73	309.73	.....	309.73
Storing plant and materials during suspension of work	.....	321.40	321.40	.....	321.40	.....	321.40
Total	29,274.14	27,051.08	56,325.22	13,777.99	70,103.21	5,751.45	64,351.76

The cofferdam is a crib coffer, 10 feet 9 inches wide with pockets 8 feet long. It extends 10 feet 8 inches below surface of No. 4 pool and 6 feet 3 inches above same. There are 439 linear feet of crib work, about 286 feet of which is sheeted with 6-inch by 12-inch triple-lap white-oak sheet piling and balance with 1-inch by 12-inch poplar. Each oak-sheet pile was made of three 2-inch by 12-inch by 25-foot oak planks. They were spiked together with two 4-inch boat spikes and 10 ¾-inch by 8-inch round spikes.

There were 286 piles driven, of an average length of 22 feet left in work. The longest was 25 feet and shortest, after sawing, was 16 feet. The piles were driven by a 3,000-pound hammer falling from 6 feet to 10 feet, and, in all cases, were driven till down 25 feet, or till they would stand no further driving.

The cofferdam was commenced on July 15 and timberwork completed on August 31. The construction was delayed somewhat on account of slow delivery of timber for sheet piles and on account of high water. The puddling of coffer was completed on September 3, and it was pumped out on same date. The pumping was done with one 10-inch centrifugal pump, which commenced work at 5 a. m., and at 12 m. the water had been lowered 8 feet and at 3 p. m. 9 feet. Actual time of pumping was about six hours and volume of water moved about 160,000 cubic feet. The coffer is a very tight one, but there were numerous springs over lock foundation

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bed and from shore side, which necessitated ten to twenty minutes pumping per hour throughout the season.

Sheet No. 1, accompanying, shows plan of artificial foundation.

The number of bearing piles actually driven in foundation is 704—two more than shown in plan. The average length of pile left in work after sawing is 15.2 feet, the maximum being 25 feet and minimum 7.7 feet.

The piles were all white oak of excellent quality, ranging from 12 inches to 20 inches in diameter at head. They were driven by a 3,000-pound hammer falling from 10 feet to 30 feet, and given from 40 blows to 228 blows. Every pile was carefully driven and as deep as was considered safe without seriously injuring it, and in all cases till the penetration was less than one-half inch for 25-foot fall of hammer. The material into which they were driven is a very compact mixture of clay, sand, and gravel.

There were 338 triple-lap white-oak sheet piles driven about foundation. Each pile was made of three pieces of 3-inch by 12-inch by 17-foot oak timber. They were spiked together with two 4-inch boat spikes, seven ¾-inch by 10-inch round spikes, and one ¾-inch by 15-inch square spikes. The average length of pile left in work is 12¼ feet; maximum, 17 feet; minimum, 12 feet. The 6-inch by 12-inch oak caps are bolted to the bearing piles with two 1-inch bolts through head of each pile. The 8-inch floor is made of two layers of 4-inch by 8-inch oak timber, so laid as to break joints. That under walls was lightly spiked with ¾-inch by 8-inch round spikes, and each layer of that in chamber with nine ¾-inch by 9-inch round spikes per 15 square feet superficial area. By actual test it was demonstrated that each of these spikes has a holding power of about 4,000 pounds.

The land wall of lock is entirely of concrete. It was placed by dividing into 11 sections. The first section was placed October 28, and the last section was completed December 1.

The starting of this work and the progress after starting was much delayed by the slow arrival of materials.

The plan of concrete forms was the same as described in report of June 30, 1896, on the improvement of Rough River, Kentucky (see Annual Report, Chief of Engineers, 1896, p. 2283), except that the backs of chamber and wing walls are stepped instead of being battered, and the sheathing on face is tongued and grooved, the tongue being one-half inch deep. The sand and gravel were the same quality as described in that report. The cement used was Saylor's Portland, an American Portland instead of foreign, and the limestone was broken by hand hammers instead of by crushers. The mixture for concrete was the same as described in that report, viz, 1 part of cement to 2 parts of sand to 2 parts of gravel to 3 parts of broken stone. The placing of concrete was done after the same plan therein described, except that the mortar facing is only about 3½ inches thick. By practice our forces have become more efficient in doing the concrete work than they were in 1896, and can now easily place a section of from 250 to 300 cubic yards in from twenty to twenty-four hours.

For the 3,141 cubic yards of concrete in land wall there were used 3,895 barrels cement, 1,224 cubic yards sand, 1,030 cubic yards gravel, and 1,850 cubic yards stone.

The total expenses for the season's work is shown in the following table:

From the details entering Tables 1 and 2 we obtain the unit costs of the most important classes of work done as shown in the following table. These unit costs include proper charges for plant, superintendence, and incidentals:

TABLE NO. 3.

	Cost per cubic yard.	Total cost.
Concrete masonry—3,141 cubic yards:		
3,895 barrels cement	$10,088.05	$3.211
1,224 cubic yards sand	2,056.32	.654
1,030 cubic yards gravel	1,668.20	.529
1,850 cubic yards stone	3,337.70	1.062
Inspecting and storing materials	1,693.04	.539
Total materials	18,838.31	5.995
Erecting and removing forms	2,528.60	.805
20 per cent of cost of material in forms and framing	1,089.80	.347
20 per cent of cost of buildings	328.60	.105
20 per cent of cost of plant	207.10	.066
80 per cent of cost of erecting mixer	61.90	.020
Labor mixing and placing concrete	3,620.75	1.152
Total labor and plant	7,836.75	2.495
Total cost of concrete	26,675.06	8.49

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TABLE No. 3—Continued.

	Cost per cubic yard.	Total cost.
Excavation for lock:		
21,650 cubic yards by dredge	$3,707.05	$0.171
98 snags ..... each	98.00	1.00
1,818 cubic yards by picks and shovels above water	1,571.38	.296
3,485 cubic yards by picks and shovels below water		
Cofferdam:		
439 linear feet, 16 feet 11 inches high ..... linear foot	4,980.32	11.35
7,085 cubic yards, fill back of land wall (inclusive of ramming)	1,170.97	.165
2,363 cubic yards grading grounds for car tracks, etc	1,266.20	.536
Lock foundation:		
704 bearing piles ..... each	3,226.00	4.58
338 9-inch by 12-inch triple-lap sheet piles ..... do	1,012.67	3.026
170,941 feet B. M. white-oak timber ..... per M	5,510.05	32.234
22,293 pounds iron ..... pound	557.22	.025

It may be well to observe that the excavation for lock by pick and shovel below water was the material moved from cofferdam after pumping it out. It was saturated with water and stuck badly to shovels. The grading of grounds included more or less work laying car tracks. The largest part of material for filling back of land wall was hoisted about 25 feet.

In the latter part of December the plant and tools and all materials on hand were stored for winter and to await the appropriation of more funds for continuing the work. Work was suspended on December 31.

The principal work remaining to be done may be briefly stated as follows: Build river wall of lock, put in gates and wickets, build guide cribs to lock, build abutment and dam, and grade and pave grounds back of land wall

I wish to testify to the faithful and energetic work of all employees during the season. I think the efficient manner in which Messrs. Butler and Flenniken performed their duties is worthy of especial mention.

Very respectfully, your obedient servant,

WM. M. HALL, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 9.

OPERATING AND CARE OF LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

For report of general project see page 2272, Report of Chief of Engineers for fiscal year ending June 30, 1896.

The estimate and project for the fiscal year 1898 contained the following items:

Regular force	$25,309.00
Repairs	42,503.39
Fuel, oil, and miscellaneous	3,180.00
Subsistence	1,360.00
Contingencies	3,500.00
Total	75,882.39

The first item covers payments to lock hands at the several locks, the regular crews of the snag boat and dredge, and employees in the local office at Bowling Green, and pro rata share of salaries in the district office at Louisville, Ky. The second item is for the construction of a concrete reenforcement to the lower end of river wall at Lock No. 4, Green River; the reconstruction of dam at Lock No. 2, Green River, and the necessary current repairs to the locks, boats, buildings, etc. The purpose of the other items is indicated: "Subsistence" being for the crew of the snag boat while in commission.

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During the year the reenforcement at Lock No. 4, Green River, was completed, and a portion of the dam at Lock No. 2, Green River, reconstructed, and the several locks and their approaches kept free from obstructions by the snag boat and dredge. The details of the year's work are set forth in the report of Mr. D. A. Watt, assistant engineer, appended hereto.

Expenditures during the year were as follows:

Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, during the fiscal year ending June 30, 1898.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	1	Pay roll	Services	$1,565.15
	2	....do	....do	425.96
	3	....do	....do	80.00
	4	....do	....do	69.96
	5	....do	....do	567.75
	6	....do	....do	58.30
	7	....do	....do	371.74
	8	....do	....do	224.40
	9	....do	....do	392.78
	10	....do	....do	285.50
	11	....do	....do	95.00
	12	....do	....do	95.00
	13	....do	....do	95.00
	14	....do	....do	4.50
	15	Randolph Clark Bryant	Timber	992.22
	16	Brown & Colburn	Broken stone	739.50
	17	R. W. Covington	Rent	20.00
	18	Pay roll	Services	302.14
	19	Charles G. Davenport	Oak lumber	1,012.50
	20	Randolph Clark Bryant	Timber	989.37
	21	Aberdeen Coal and Mining Co	Towing	92.47
	22	The Ahrens & Ott Manufacturing Co.	Fittings, etc	72.46
	23	East Tennessee Telephone Co	Telephone service	60.00
	24	John P. Morton & Co	Stationery	55.25
	25	Bridges Strassel Co	Glass	52.39
	26	J. P. Will Co	Lumber	38.20
	27	Recktenwald Bros	Scuppers, etc	18.10
	28	Queen City Supply Co	Supplies	17.62
	29	Enterprise Brass Manufacturing Co.	Stair railings	17.20
	30	Phil A. Vogel & Sons	Packing, etc	8.73
	31	Roemer Bros	Shingles	7.00
	32	Albrecht & Heick	Iron, etc	6.17
	33	The Lunkenheimer Co	Lubricator, etc	5.45
	34	Peter Bitzer	Bricks	2.25
	35	McKibbin Bros	Supplies	76.14
	36	Jas. F. Phillips	Coal	55.63
	37	A. Button & Son	Supplies	37.12
	38	W. G. Daughtry	Subsistence supplies	31.96
	39	Northern Lake Ice Co	Ice	21.24
	40	W. A. Guenther & Sons	Lime	16.80
	41	W. B. Belknap & Co	Hardware	12.34
	42	Peaslee-Gaulbert Co	Globes, etc	5.40
	43	Chas. Hegewald Co	Boiler tiles	3.60
	44	Bowling Green Ice and Cold Storage Co.	Ice	7.75
	45	Sulzer Vogt Machine Co	Repairs, etc	76.06
	46	M. M. Buck Manufacturing Co	Hardware	1,084.55
August	1	M. A. Sweeney Co	Repairing snag boat	599.65
	2	J. G. Warren, captain, Corps of Engineers.	Mileage	4.56
	3	Pay roll	Services	435.50
	4	....do	....do	95.00
	5	....do	....do	95.00
	6	....do	....do	95.00
	7	....do	....do	95.00
	8	....do	....do	95.00
	9	....do	....do	316.08
	10	....do	....do	635.67
	11	....do	....do	30.00
	12	....do	....do	52.61
	13	....do	....do	279.97
	14	....do	....do	430.00
	15	Henry Blackburn	....do	12.45
	16	Commercial Wood and Cement Co	Cement	3,024.00
	17	Randolph Clark Bryant	Timber	742.90

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
August....	18	H. C. Threlkel	Oak timber	$427.55
	19	W. G. Daughtry	Subsistence supplies	189.29
	20	The J. T. Burghart Co	Linoleum, etc	176.38
	21	W. H. McKnight, Sons & Co	Shades, etc	64.50
	22	Jas. F. Phillips	Coal	51.00
	23	G. F. Stickney	Traveling expenses	51.38
	24	Geo. L. Vogel	Meat	24.34
	25	Green River Coal and Mining Co	Coal	19.25
	26	The Otis Hidden Co	Stair plates	18.04
	27	J. N. Martin, jr	Traveling expenses	9.39
	28	John Lankford	do	8.85
	29	Favorite Ice and Coal Co	Ice	2.65
	30	E. T. O'Brien	Services	1.95
	31	Model Meat Market, T. J. Jones, prop.	Beef	1.35
	32	Eigenmann, Hollerbach & Co	Sand	165.50
September.	1	Pay roll	Services	801.53
	2	do	do	380.33
	3	do	do	95.00
	4	do	do	95.00
	5	do	do	95.00
	6	do	do	95.00
	7	Jas. Clark, jr., & Co	Electric-light plant	915.00
	8	E. S. Overstreet	Services	48.00
	9	Pay roll	do	96.50
	10	do	do	372.50
	11	do	do	296.20
	12	do	do	876.17
	13	do	do	331.56
	14	do	do	135.90
	15	do	do	28.20
	16	do	do	19.05
	17	do	do	11.10
	18	Charles G. Davenport	Lumber	1,620.00
	19	Randolph Clark Bryant	Retained percentage	302.70
	20	L. R. Maddox & Co	Coal	117.09
	21	W. G. Daughtry	Subsistence supplies	92.83
	22	Aberdeen Coal and Mining Co	Coal	72.92
	23	Frederick Diehl	Stationery	53.67
	24	Geo. L. Vogel	Meat	23.21
	25	J. B. Speed & Co	Cement, etc	20.35
	26	R. W. Covington	Rent	20.00
	27	do	do	20.00
	28	Geher & Son	Oil tanks, etc	18.30
	29	Evansville Oil Co	Oil	17.04
	30	A. Button & Son	Brooms, etc	15.00
	31	Sam M. Bauer	Apollinaris water	11.50
	32	Thomas Walker	Services	11.40
	33	Green River Coal and Mining Co	Coal	10.90
	34	Frank Tardy	Brooms, etc	10.20
	35	Clarence Carter, master	Traveling expenses	4.01
	36	Aberdeen Coal and Mining Co	Coal	170.21
	37	Milton W. Barkhouse	Supplies	87.06
	38	W. B. Belknap & Co	Hardware	50.39
	39	Kaufman, Straus & Co	Pillowcases, etc	40.08
	40	D. Lyon Skiff Co	Skiffs	40.00
	41	James F. Nutty, chief clerk	Traveling expenses	15.81
	42	Courier-Journal Job Printing Co	Stationery	11.20
	43	Peaslee-Gaulbert Co	Supplies	137.75
	44	Pay roll	Services	1.35
	45	do	do	6.60
	46	do	do	52.45
	47	do	do	11.66
	48	J. P. Will Co	Drawing case	55.00
	49	Evansville, Ohio and Green River Transportation Co.	Freight charges	.50
		War Department	Stationery	21.63
October....	1	Pay roll	Services	17.70
	2	do	do	285.00
	3	do	do	434.64
	4	do	do	136.44
	5	do	do	47.45
	6	do	do	857.62
	7	do	do	469.69
	8	do	do	355.11
	9	do	do	103.05
	10	do	do	112.30
	11	do	do	2.40
	12	do	do	8.70
	13	do	do	.90

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
October....	14	Pay roll	Services	$3.15
	15	.....do	.....do	8.60
	16	.....do	.....do	26.70
	17	.....do	.....do	95.00
	18	.....do	.....do	95.00
	19	.....do	.....do	95.00
	20	.....do	.....do	95.00
	21	.....do	.....do	95.00
	22	.....do	.....do	362.12
	23	.....do	.....do	774.84
	24	Aberdeen Coal and Mining Co	Coal	82.07
	25	Standard Oil Co	Oil	62.48
	26	W. G. Daughtry	Subsistence supplies	50.88
	27	R. W. Covington	Rent	20.00
	28	Levi Morgan, engineer	Traveling expenses	3.10
	29	Morris Machine Works	Pump gland	3.00
	30	R. M. Cunningham	Timber	4,348.59
	31	J. G. Warren, captain, Corps of Engineers.	Mileage	9.12
	32	J. P. Lynch, clerk	Traveling expenses	12.11
	33	Holt & Brandon Ice and Cold Storage Co.	Ice	80.60
	34	East Tennessee Telephone Co	Telephone service	60.00
	35	E. Sweeney	Stove liners	9.40
	36	Walter N. Escott	Photographic supplies	5.62
	37	Baltimore and Ohio Southwestern Railway Co.	Transportation	7.00
	38	The Western Union Telegraph Co	Telegrams	1.60
	39	The Todd-Donigan Iron Co	Wheelbarrows	78.75
	40	Jas. F. Phillips	Coal	20.80
	41	John M. G. Watt, draftsman	Traveling expenses	17.51
	42	Postal Telegraph Cable Co	Telegrams	3.89
	43	Geher & Son	Hardware	3.73
	44	Favorite Ice and Coal Co	Ice	2.60
	45	Alex. Morgan	Services	4.05
	46	Pay roll	.....do	4.50
	47	The Ahrens & Ott Manufacturing Co.	Pittings, etc	167.69
	48	A Button & Son	Supplies	40.48
	49	W. B. Belknap & Co	Hardware	5.56
	50	Elwood Wingfield, deck hand	Traveling expenses	4.32
November.	1	Milton W. Barkhouse	Supplies	9.45
	2	S. A. Bishop, watchman	Traveling expenses	4.92
	3	J. N. Martin, jr., clerk	.....do	4.35
	4	G. F. Stickney, asst. engineer	.....do	53.07
	5	Pay roll	Services	794.33
	6	.....do	.....do	95.00
	7	.....do	.....do	95.00
	8	.....do	.....do	3.60
	9	.....do	.....do	95.00
	10	.....do	.....do	95.00
	11	.....do	.....do	285.00
	12	.....do	.....do	75.50
	13	.....do	.....do	115.00
	14	.....do	.....do	862.77
	15	.....do	.....do	142.50
	16	.....do	.....do	393.77
	17	.....do	.....do	476.10
	18	.....do	.....do	771.60
	19	.....do	.....do	151.95
	20	.....do	.....do	261.32
	21	.....do	.....do	82.05
	22	.....do	.....do	363.40
	23	.....do	.....do	8.40
	24	.....do	.....do	31.35
	25	D. W. Dame	.....do	3.60
	26	Louis Haas, deck hand	Traveling expenses	4.32
	27	The Bucyrus Co	Dredge parts	47.96
	28	R. W. Covington	Rent	20.00
	29	Pay roll	Services	597.62
	30	L. R. Maddox & Co	Coal	80.66
	31	Johnson & Hill	Boom	15.00
	32	Aberdeen Coal and Mining Co	Coal	169.79
	33	Model Meat Market	Beef, mutton, and pork	32.07
	34	J. L. Cole	Beef	11.16
	35	Geo. L. Vogel	.....do	27.45
	36	The Wells Light Manufacturing Co	Wells lights	315.00
	37	Barnet J. Morehead	Beef	35.17
	38	Evansville, Ohio and Green River Transportation Co.	Transportation	.50

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
November.	39	W. B. Belknap & Co	Supplies	$152.60
	40	Northern Lake Ice Co	Ice	7.28
	41	B. Cohron	Beef	17.10
	42	Pat Grady	Services	34.50
	43	Bedford, Weikel & Nugent	Gravel	220.80
	44	Courier-Journal Job Printing Co	Paper	8.50
	45	Frederick Diehl	Stationery	4.20
	46	Pay roll	Services	760.00
	47	do	do	439.35
	48	do	do	458.70
	49	do	do	181.95
	50	do	do	17.10
	51	do	do	12.90
	52	do	do	3.67
December.	1	do	do	16.38
	2	do	do	35.18
	3	W. B. Belknap & Co	Trucks	12.75
	4	Pay roll	Services	538.25
	5	do	do	285.00
	6	do	do	95.00
	7	do	do	95.00
	8	do	do	95.00
	9	do	do	95.00
	10	do	do	95.00
	11	do	do	287.70
	12	Chas. Hegewald Co	Bulkheads, etc	339.74
	13	Pay roll	Services	820.67
	14	Fred W. Keisker & Son	Furniture	122.40
	15	Model Meat Market	Beef	6.75
	16	J. G. Warren, captain, Corps of Engineers.	Mileage	9.12
	17	W. A. Guenther & Sons	Timber	29.55
	18	Chas. R. Buck	Services	22.50
	19	Willie Marshall	do	3.30
	20	John Faanacht	do	22.50
	21	V. D. Fulkerson	Turkey	2.48
	22	G. W. Cook	Beef	8.06
	23	W. G. Daughtry	Subsistence supplies	250.99
	24	C. A. Koster	Flags	24.60
	25	W. G. Daughtry	Pork	6.00
	26	L. R. Maddox & Co	Coal	33.17
	27	R. W. Covington	Rent	20.00
	28	Pay roll	Services	34.00
	29	Park City Coal Co	Coal	4.50
	30	Aberdeen Coal and Mining Co	Stone and coal	1,758.11
	31	Favorite Ice and Coal Co	Ice	.70
	32	Sulzer-Vogt Machine Co	Condenser pipes	57.00
	33	M. M. Buck Manufacturing Co	Supplies	23.11
	34	Louisville and Nashville R. R	Transportation	3.41
	35	The Todd-Donigan Iron Co	Supplies	25.39
	36	Carr & Stone	Drayage	2.50
	37	Peaslee-Gaulbert Co	Lanterns, etc	32.02
	38	McKibbin Bros	Subsistence supplies	26.90
	39	Model Meat Market	Meat	11.15
	40	Standard Oil Co	Oil	25.90
	41	W. B. Belknap & Co	Supplies, etc	60.45
	42	Holt & Brandon Ice and Cold Storage Co.	Ice	74.65
	43	C. W. Bivens	Services	19.65
	44	Milton W. Barkhouse	Supplies	65.28
	45	Pay roll	Services	4.50
	46	Jas. Clark, jr., & Co	Annunciator	10.50
	47	W. B. Belknap & Co	Iron	8.39
	48	M. M. Buck Manufacturing Co	Die, etc	3.00
	49	A. H. McKinley	Services	19.50
	50	A. D. Rigsby	do	3.64
1898.				
January	1	Pay roll	do	737.99
	2	do	do	285.00
	3	do	do	250.50
	4	do	do	95.00
	5	do	do	174.30
	6	do	do	95.00
	7	do	do	95.00
	8	do	do	95.00
	9	R. T. Williams, master steamer J. C. Kerr.	Transportation	.25
	10	Pay roll	Services	42.45
	11	do	do	70.80

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
January ...	12	Charles G. Davenport	Oak timber	$850.32
	13	.....do	Retained percentage	386.97
	14	Indiana Forge and Rolling Mill Co	Iron	11.82
	15	R. W. Covington	Rent	20.00
	16	W. G. Daughtry	Subsistence supplies	114.70
	17	Model Meat Market	Meat	26.85
	18	East Tennessee Telephone Co	Telephone service	60.00
	19	L. R. Maddox & Co	Coal	10.12
	20	The Cincinnati Railway Supply Co	Rope, etc	282.58
	21	Standard Oil Co	Oil	22.76
	22	Park City Coal Co	Coal	4.50
	23	Aberdeen Coal and Mining Co	.....do	187.75
	24	Pay roll	Services	7.25
	25	.....do	.....do	23.10
	26	W. B. Belknap & Co	Wire cloth	2.30
	27	Pay roll	Services	675.00
February ..	1	.....do	.....do	612.18
	2	.....do	.....do	92.40
	3	.....do	.....do	288.00
	4	.....do	.....do	95.00
	5	.....do	.....do	95.00
	6	.....do	.....do	97.70
	7	.....do	.....do	98.60
	8	.....do	.....do	145.40
	9	Postal Telegraph Cable Co	Telegram	.45
	10	Cumberland Telephone and Telegraph Co.	Telegrams	1.07
	11	Charley Bright	Services	9.45
	12	R. H. Sands	.....do	.60
	13	R. W. Covington	Rent	20.00
	14	G. F. Stickney, assistant engineer	Traveling expenses	2.00
	15	T. B. Hopkins & Bro	Tinsmith work	55.00
	16	W. G. Daughtry	Supplies	84.49
	17	W. S. Overstreet, master	Traveling expenses	5.74
	18	Jas. Clark, jr., & Co	Supplies, etc	2.25
	19	Brown & Colburn	Ash pan, etc	21.12
	20	Standard Oil Co	Oil	7.91
	21	Aberdeen Coal and Mining Co	Coal	37.83
	22	Peasles-Gaulbert Co	Supplies	8.00
	23	F. C. Nunemacher	Blank book, etc	10.50
	24	Louisville and Nashville Railroad Co	Transportation	6.82
	25	Louisville, Evansville and St. Louis Consolidated Railroad.	.....do	3.75
	26	Holt & Brandon Ice and Cold Storage Co.	Ice	7.39
	27	Bowling Green Ice and Cold Storage Co	.....do	2.40
March	1	J. H. Rummage	Services	12.60
	2	Pay roll	.....do	490.83
	3	.....do	.....do	285.00
	4	.....do	.....do	205.50
	5	.....do	.....do	95.00
	6	.....do	.....do	140.00
	7	.....do	.....do	98.00
	8	.....do	.....do	95.00
	9	.....do	.....do	139.85
	10	Pullman Palace Car Co	Transportation	1.00
	11	The Western Union Telegraph Co	Telegrams	.74
	12	Aberdeen Coal and Mining Co	Coal	52.65
	13	W. G. Daughtry	Supplies	58.84
	14	Model Meat Market	Beef	25.29
	15	Park City Coal Co	Coal	4.50
	16	R. W. Covington	Rent	20.00
	17	R. H. Sands	Services	3.60
	18	C. M. Maddox & Co	Coal	13.10
	19	Oliver Johnson	Services	2.10
	20	Frederick Diehl	Paper	2.30
	21	Chas. E. Beecher	Stamps	.90
	22	Roemer Bros	Lumber, etc	27.67
	23	Phil A. Vogel & Sons	Supplies	12.00
April	1	Pay roll	Services	285.00
	2	.....do	.....do	163.68
	3	.....do	.....do	97.40
	4	.....do	.....do	140.00
	5	.....do	.....do	95.00
	6	.....do	.....do	95.00
	7	.....do	.....do	95.00
	8	.....do	.....do	485.15
	9	Park City Steam Laundry Co	Laundry work	7.67
	10	R. W. Covington	Rent	20.00

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Green and Barren rivers, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
April	11	W. G. Daughtry	Supplies	$7.60
	12	East Tennessee Telephone Co	Telephone service	60.00
	13	C. M. Maddox & Co	Coal	22.92
	14	Park City Coal Co	do	4.50
	15	J. B. Speed & Co	Lime	10.80
	16	Courier-Journal Job Printing Co	Paper	4.50
	17	Peaslee-Gaulbert Co	Supplies	386.10
	18	W. B. Belknap & Co	Drills	17.85
May	1	Courier-Journal Job Printing Co	Job printing	11.50
	2	J. N. Martin, jr., clerk	Traveling expenses	14.50
	3	G. F. Stickney, assistant engineer	do	10.45
	4	Evansville and Bowling Green Packet Co.	Freight	2.10
	5	The Ahrens & Ott Manufacturing Co	Water-closet bowl	10.00
	6	Pay roll	Services	99.60
	7	do	do	289.00
	8	do	do	495.85
	9	Kentucky Scale Co	Platform scale	42.00
	10	R. W. Covington	Rent	20.00
	11	John C. Lewis Co	Sheets	51.00
	12	F. C. Nunemacher	Supplies	10.45
	13	Pay roll	Services	95.00
	14	do	do	140.00
	15	do	do	105.80
	16	do	do	102.80
	17	do	do	95.00
	18	G. F. Stickney, assistant engineer	Traveling expenses	11.57
	19	The Evansville and Bowling Green Packet Co.	Freight charges	1.80
	20	F. C. Nunemacher	Job printing	24.80
	21	Chas. Hegewald Co	Fire brick, etc	64.80
	22	Brown & Colburn	Escape pipe, etc	33.98
	23	W. B. Belknap & Co	Supplies	30.73
	24	Roemer Bros	Lumber	61.75
	25	Milton W. Barkhouse	Pipe stocks	16.00
	26	The Cincinnati Railway Supply Co	Crib spikes	218.36
	27	Model Meat Market	Subsistence supplies	15.25
June	1	Pay roll	Services	375.00
	2	J. P. Lynch, clerk	Traveling expenses	18.71
	3	Pay roll	Services	95.00
	4	do	do	95.00
	5	do	do	181.66
	6	do	do	95.00
	7	do	do	95.00
	8	do	do	547.38
	9	Phil A. Vogel & Sons	Packing	10.75
	10	Model Meat Market	Beef	14.18
	11	F. L. Kister, jr	Doors, etc	4.90
	12	Model Meat Market	Beef	4.68
	13	W. G. Daughtry	Supplies	74.73
	14	R. W. Covington	Rent	20.00
	15	M. Fleming	Tableware	6.00
	16	Favorite Ice and Coal Co	Ice	1.35
	17	Louisville Pillow Co	Mattresses, etc	19.00
	18	Aberdeen Coal and Mining Co	Coal	47.71
	19	J. B. Speed & Co	Salt	4.80
	20	Grainger & Co	Operating spar	15.00
	21	Frank Tardy	Supplies	17.22
	22	Bowling Green Ice and Cold Storage Co	Ice	3.00
	23	Peaslee-Gaulbert Co	Supplies	18.78
	24	Jerry Wilson	Services	9.33
	25	W. B. Belknap & Co	Supplies	32.53
	26	do	do	99.96
	27	S. Semonin, master, steamer Eleanor	Freight charges	.25
	28	Henry M. Robert, colonel, Corps of Engineers.	Mileage	44.16
	29	J. G. Warren, captain, Corps of Engineers.	do	9.48
	30	Model Meat Market	Meat	15.75
	31	Frederick Diehl	Stationery	2.93
	32	Geher & Son	Water buckets, etc	13.15
		Total expended		64,779.61

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AMOUNTS AND DATES OF APPROPRIATIONS AND ALLOTMENTS.

Appropriation.

August 11, 1888	$135,000.00

Allotments.

January 4, 1889	$167,112.00
July 20, 1889	139,110.00
July 17, 1890	53,783.47
July 16, 1891	77,807.26
July 15, 1892	46,264.26
July 15, 1893	49,730.88
July 13, 1894	25,927.23
January 26, 1895	6,000.00
July 20, 1895	51,080.31
September 2, 1896	77,684.35
July 23, 1897	57,459.61
Total	886,959.37

REPORT OF MR. D. A. WATT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations pertaining to operating and care of canals, etc., Green and Barren rivers, during the fiscal year ending June 30, 1898:

LOCK NO. 1, GREEN RIVER.

General work.—Painted both sets of lock gates and whitewashed the fences and outbuildings twice during the year, and renewed the tin gutters on the roofs of the two lock houses.

Highest water occurred April 2, 1898, the upper gauge reading 34.3 feet. Lowest water occurred above the dam from October 10 to 13, 1897, inclusive, the upper gauge reading 4.4 feet; and below the dam October 7, 1897, the lower gauge reading 2.1 feet. The lock walls were submerged forty-nine days during the year.

LOCK NO. 2, GREEN RIVER.

Repairs to dam.—A section of dam 207 feet long has been rebuilt complete, and the lower slope and apron of a section of the old dam, 67 feet long, has been remodeled to correspond with the new work. The new structure is a slope dam, having an apron on the lower side, consisting of timber cribs filled with stone. It is constructed of sawed timber throughout, and is founded on rock, and has an average height of about 13½ feet.

The dam has a total width of 56 feet 4 inches, divided as follows: Upper slope, 19 feet 3 inches; lower slope, 22 feet 1 inch; apron, 15 feet. The frame of the dam consists of 12 by 12 inch timber, laid without notching. The apron is sheathed with 10-inch oak; the lower slope with 6-inch oak; the upper slope with a double lap of 3-inch oak, breaking joints, and the upper breast with a double lap of 2-inch oak, breaking joints. The dam was filled with 1,617 cubic yards newly quarried stone and with 1,823 cubic yards filling from the old dam and slate wheeled in barrows from the loose slate beds below the dam. The entire section was inclosed on the upper side with a cofferdam and built continuously. The cofferdam was double-walled and was built extending about 60 feet beyond the new work, and has been removed, with the exception of about 120 linear feet at the end, partially inclosing the section of the old dam yet to be rebuilt. To give additional stability during the high-water season, 325 cubic yards of stone were placed on the upper slope of the dam, at the junction of the old and new work, and on the cofferdam.

The following materials were on hand at the beginning of the fiscal year:

Gum timber	feet B. M..	134,828
White oak timber	do....	78,576
Yellow pine timber	do....	65,333
Iron, spikes, etc	pounds..	47,582

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The following materials were received during the year:

Gum timber	feet B. M.	122,452
White oak timber	do	179,410
Yellow pine timber	do	206,454
Poplar timber	do	9,856
Stone	cubic yards	1,942

all of which, with the exception of the stone, were contracted for the preceding year and were included in the outstanding liabilities for that year.

The following materials were used in the work:

Timber:		
Frame of dam, 12 by 12 inch gum timber	feet B. M.	183,552
Frame of dam, 12 by 12 inch yellow pine	do	19,776
Sheathing, white oak timber	do	131,667
Cofferdam, yellow pine	do	14,776
Cofferdam, poplar	do	4,752
Total		359,523
Iron:		
1 by 1 by 30 inch crib spikes	pounds	1,928
¾ by ¾ by 22 inch crib spikes	do	12,129
¾ by ¾ by 15 inch crib spikes	do	2,681
¾ by ¾ by 9 inch boat spikes	do	1,000
¾ by ¾ by 7 inch boat spikes	do	550
Wire nails	do	200
Total		18,488
Stone	cubic yards	3,765

The following is a statement of the expenditures during the year:

Labor:		
Receiving materials	$353.67	
Building cofferdam	443.99	
Removing cofferdam	28.30	
Tearing out old dam	1,040.51	
Laying timber	1,314.24	
Filling dam with stone	1,339.23	
Excavating foundation	798.89	
Miscellaneous	892.08	
		$6,210.91
Material:		
Stone	1,650.70	
Crib spikes	218.36	
Oil	69.65	
Coal	13.59	
Miscellaneous	117.03	
		2,069.33
Total expenditures		8,280.24

The following orders are outstanding for material which has not yet been received:

Stone	$899.30	
Gum timber	741.89	
White oak	703.50	
Yellow pine	288.00	
		2,632.69
Total		10,912.93

General work.—Painted both sets of lock gates and whitewashed the fences and outbuildings twice during the year, and painted 6 gates and 18 check posts.

Highest water occurred January 30 and 31, 1898, the upper gauge reading 30.5 feet. Lowest water occurred from September 24 to 30, 1897, inclusive, the upper gauge reading 6.3 feet. The lock walls were submerged forty-nine days during the year.

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LOCK NO. 3, GREEN RIVER.

General work.—Painted both sets of lock gates and whitewashed the fences and outbuildings twice during the year.

Highest water occurred March 31, 1898, the upper gauge reading 37.1 feet. Lowest water occurred from September 24 to October 6, 1897, inclusive, the upper gauge reading 6.5 feet. The lock walls were submerged thirty-seven days during the year.

LOCK NO. 4, GREEN RIVER.

Repairs to river lock wall.—A concrete reinforcement to the lower end of the river lock wall has been built complete. It has a total length of 103 feet, an average height of 33 feet, and contains 788 cubic yards of concrete. This wall is 3 feet wide on top, and its face has a batter of 7 feet in a height of 30 feet. A double-wall cofferdam, 16 feet high, 280 feet long, was built to inclose the lower end of the lock, which was then pumped dry, and the foundation for the concrete reinforcement excavated down to solid rock. The wall was divided longitudinally into 5 sections, making each section about 20 feet long. The concrete was deposited in forms constructed of 4 by 8 inch dressed yellow pine timber, set up against posts 8 by 10 inches, spaced 5 feet apart, the lower parts of which were supported at equal intervals vertically by 3 6 by 8 inch timber braces, and the upper part by 4 1¼ inch tie-rods anchored in the masonry of the old wall. The tie-rods were in two sections, connected by a turn-buckle. After the concrete had set, the outer portions of the tie-rods were unscrewed, leaving the turn-buckles in the mass of concrete, and the holes were filled with concrete. The alternate sections were filled first, and after allowing three days for the concrete to set, the partitions were removed and the intermediate sections filled. The concrete consisted of 1 part Saylor's Portland cement, 2 parts washed Ohio River sand, 2 parts washed Ohio River gravel, and 3 parts of clean broken limestone of a size to pass through a 2-inch ring. The concrete was mixed in a 4-foot cubical mixer, in batches of about 20 cubic feet each. The materials were placed in the mixer dry, to which were added about 18 gallons of water, and the mixer then revolved 11 times. The concrete was spread in layers about 6 inches thick and thoroughly tamped. Wells 1 foot square, about 10 feet apart, were formed in each section to supply water to the concrete while setting. After the mass had thoroughly set these wells were filled with concrete. A 3-inch dressing, composed of 1 part cement and 2 parts sand, was spread over the entire work to give a smooth finish. After allowing the concrete five days to set the forms were removed. The following table shows the progress made in mixing and placing the concrete in the wall:

Section.	Height.	Time required to fill.	Materials.				Total number cubic yards concrete.
			Barrels of cement.	Cubic yards sand.	Cubic yards gravel.	Cubic yards stone.	
	Feet.	*Hours.*					
1	31	9½	152	42.2	42.2	63.3	113
3	33	19	227	63.1	63.1	94.7	168
5	35	15	246	68.4	68.4	102.6	182
2	32	11	200	55.6	55.6	83.4	148
4	35	13	228	63.3	63.3	95	169
Total			1,053	292.6	292.6	439	780

Used for dressing, 8 cubic yards concrete.

A blacksmith shed, 14 feet by 24 feet, was built, and a deck barge, 32 feet long, 8 feet wide, and 2½ feet deep, was constructed to facilitate the handling of material. The lock was closed to navigation from August 27, 1897, to October 11, 1897, inclusive.

The following materials were on hand at the beginning of the year:

Yellow pine timber	feet B. M..	29,430
Red oak timber	do....	38,187
Iron for concrete forms	pounds..	7,243
Iron for cofferdam	do....	11,961
Saylor's Portland cement	barrels..	1,120
Broken stone for concrete	cubic yards..	493

The following materials were received during the year:

Red oak timber	feet B. M..	682
Sand	cubic yards..	331
Gravel	do....	320
Iron	pounds..	200
Coal	bushels..	3,819

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all of which, with the exception of the iron and coal, were ordered the preceding year, and were included in the outstanding liabilities for that year in the last Annual Report.

The following materials were used in the work:

Yellow pine timber for concrete forms	feet B. M..	40,213
Red oak timber for cofferdam	do....	38,869
Iron for concrete forms	pounds..	7,443
Iron for cofferdam	do....	11,950
Saylor's Portland cement	barrels..	1,078
Sand	cubic yards..	300
Gravel	do....	295
Broken stone	do....	444

Detailed statement of the total cost of the work, including expenditures, during the preceding year.

Labor:		
Receiving materials	$415.88	
Building cofferdam	1,032.08	
Removing cofferdam	70.19	
Erecting and removing plant	304.44	
Building and removing concrete forms	806.97	
Mixing and placing concrete	526.44	
Excavating site for wall	94.09	
Pumping cofferdam	404.59	
Miscellaneous	767.61	
		$4,422.29
Material:		
1,120 barrels Saylor's Portland cement, at $2.70	3,024.00	
493 cubic yards broken stone, at $1.50	739.50	
331 cubic yards sand, at 50 cents	165.50	
320 cubic yards gravel, at 69 cents	220.80	
10,615 feet B. M. yellow pine timber, at $17.20	182.58	
38,869 feet B. M. red oak, at $11	427.55	
19,393 pounds iron	345.82	
3,819 bushels coal	112.46	
Miscellaneous	178.82	
		5,397.03
Total		9,819.32
Expenditures during preceding year—		
Labor	282.35	
Material	5,115.84	
		5,398.19
Expenditures during the year		4,421.13

Filling and grading behind land wall.—This work, which was described in the last Annual Report, has been completed during the year. A retaining wall has been built across the old mill race, extending from the end of the wing wall at the upper end of the lock to the slate bluff opposite. The wall has a concrete foundation containing 6½ cubic yards of concrete; 66¼ cubic yards of mud were excavated for the foundation. The wall contains 40 cubic yards of stone. The mill race has been filled and the top spread evenly with 6 cubic yards of gravel. Two hundred and twenty-six square yards of paving, consisting of thin bedded stone set on edge, has been laid back of the lock wall.

General work.—Painted both sets of lock gates and whitewashed fences and outbuildings twice during the year. Cut ditches and graded hillside to carry off rain water, and graded the slope back of the warehouse, handling in all 271 cubic yards of earth and stone. Unloaded from barge and stored in warehouse, pump, boiler, tools, etc.; renewed the tin gutters on the lock master's house; built 172 linear feet of woven-wire fence along the public road south of the warehouse; placed an iron ladder in the recess in the lock wall below the lower land gate; placed battens in the wicket openings in the gates where the timber had worn away, and made minor repairs to the dam.

Highest water occurred January 26, 1898, the upper gauge reading 29.3 feet; lowest water occurred from October 14 to October 20, 1897, inclusive, the upper gauge reading 5.6 feet. The lock walls were submerged twenty-four days during the year.

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LOCK NO. 1, BARREN RIVER.

General work.—Painted both sets of lock gates and whitewashed fences and outbuildings twice during the year; placed 500 cubic yards of hickory lathe turnings on the upper slope of the dam, to stop the leaks in same; renewed the tin gutters on the roofs of both lock houses.

Highest water occurred January 25, 1898, the upper gauge reading 20.6 feet; lowest water occurred October 9 and 10, 1897, the upper gauge reading 4.8 feet. The lock walls were submerged three days during the year.

U. S. SNAG BOAT WM. PRESTON DIXON.

Repairs to snag boat.—The machinery has been thoroughly overhauled and painted, the main deck calked, new liners placed in fire fronts, furnace fire beds rebuilt, boilers replastered, wheel reriveted and provided with new bucket planks; and the boat has been repainted as follows: Hull, shears, stacks, knees, stationary fenders, lower bulkheads, forward cabin, stateroom floors, boiler-deck guards, boiler and hurricane deck railings and nosings, and smokestacks.

Operating snag boat.—The snag boat has been in commission two hundred and sixty-one days during the year. In addition to the regular snagging operations the boat has been engaged in towing dredge, scows, barges, and derrick boats between the several locks, in making a trip to Louisville, where an electric lighting plant was installed, and in acting as tender to the dredge for six days at Boat Island and Cow Ford on Barren River. The crew of the snag boat loaded 172,875 feet B. M. timber on barges, unloaded 150,000 feet B. M., and assisted in unloading 105,173 feet B. M. The crew backed the dam at Lock No. 1, Barren River, with 500 cubic yards hickory lathe turnings, the cofferdam at Lock No. 4, Green River, with 300, and the cofferdam at Lock No. 2, Green River, with 400 cubic yards. The crew also assisted in filling the last section of the concrete reenforcing wall at Lock No. 4, Green River, and in removing the cofferdam at the lower entrance to that lock. Fifty-three old piles and 20 caps were pulled and removed from the shore side of the upper entrance to Lock No. 2. During the year the snag boat ran 7,085 miles. The snagging operations during the year were as follows:

	Snags removed.	Trees cut.	Trees deadened.
Below lock No. 1, Green River	35	.....	.....
Between locks No. 1 and 2, Green River	240	29	12
Between locks No. 2 and 3, Green River	401	10	42
Between locks No. 3 and 4, Green River	314	27	25
Green River above mouth of Barren River	49	296	6,130
Between lock No. 4, Green, and lock No. 1, Barren	208	16	7
Between lock No. 1, Barren and Bowling Green	28	82	.....
Total	1,275	460	6,216

U. S. DREDGE NO. 1, GREEN RIVER.

[Formerly U. S. dredge boat B. O. Lermond.]

Repairs to dredge.—Painted forward and after main decks; main, boiler, and cabin deck guards; gunwales and rakes above water line; A frame, spud frames, etc, lower bulkheads, inside of cabin on boiler deck, and machinery. Repaired dipper and boom, and framed and put in place a new anchor timber for dredge mast. Calked the dredge hull and two dump scows.

Operating dredge.—The crew of the dredge assisted in loading on barges 44,415 feet B. M. timber at Thomas Landing, on Barren River; in constructing, repairing, pumping out, and removing the cofferdam at Lock No. 4, Green River; in cleaning and setting up machinery, setting up concrete mixer, repairing tools, loading machinery on barges, handling barges, etc., at Lock No. 4, Green River; in building and removing the cofferdam at Lock No. 2, Green River, and in removing plant and piling dam timber out of the reach of high water at Lock No. 2, Green River.

The following dredging has been done:

	Cu. yds.	Cu. yds.
Lock No. 1, Green River:		
From upper entrance		1,500
Lock No. 2, Green River:		
From upper entrance	5,285	
From foundation for cofferdam	1,965	
		7,250

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	Cu. yds.	Cu. yds.
Lock No. 3, Green River:		
From upper entrance	1,200	
From lock chamber	400	
		1,600
Lock No. 4, Green River:		
From upper entrance	3,720	
From lower entrance	1,450	
From lock chamber	65	
From bar below lock	3,945	
From cofferdam	3,500	
From outside of river wall	400	
		13,084
Lock No. 1, Barren River:		
From upper entrance	1,550	
From lock chamber	75	
From below lock	850	
		2,475
Cow Ford, on Barren River		2,375
Boat Island, on Barren River		1,450
Aberdeen, on Green River		300
Total		30,034

In addition to the above, sunken timber has been removed as follows:

	Lin. ft.
From the upper entrance to Lock No. 4, Green River	500
From the lower entrance to Lock No. 4, Green River	600
From the upper entrance to Lock No. 1, Barren River	100
From the lower entrance to Lock No. 1, Barren River	75
From below Lock No. 1, Barren River	1,556
Total	2,831

The dredge was in winter quarters from December 15, 1897, to February 17, 1898, inclusive; and from March 9, 1898, to June 10, 1898, inclusive.

U. S. TOWBOAT COL. G. L. GILLESPIE.

The *Gillespie* was engaged in towing barges of timber to Lock No. 2, Green River, and sand and gravel to Lock No. 4, Green River, and doing general towing. Up to September 1, 1897, on which date the boat arrived at Louisville, Ky., with the Wabash River dredge boat in tow, the following work had been done: Loaded barges towed, 11; empty barges, 19; derrick boats, 4; dredge boats, 3; dump scows, 4. Total number of miles run, 2,385.

DERRICK BOATS AND BARGES.

The fleet of derrick boats and barges has been placed in winter quarters at Calhoun, Ky., in charge of a watchman. Two derrick boats and 2 deck barges have been calked.

General.—A survey has been made of the land adjacent to Lock No. 1, Barren River.

There is transmitted herewith a list of the boats plying on Green and Barren Rivers during the year, and a report of the traffic and commerce through the locks.

Very respectfully, your obedient servant,

D. A. WATT, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

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Statement of traffic passing the locks on Green and Barren rivers during the fiscal year ending June 30, 1898.

Kind of craft.	Number.	Tonnage.
Lock No. 1, Green River.		
Passenger boats	492	75,763.47
Towboats	630	36,060.70
Government boats	29	4,001.10
Barges	882	145,818.35
Small crafts	171	2,874.93
Rafts	340	.....
Total	2,544	264,518.55

Total number of lockages, 2,581.
The lock walls were submerged 49 days during the year.

Kind of craft.	Number.	Tonnage.
Lock No. 2, Green River.		
Passenger boats	528	81,282.05
Towboats	509	27,704.88
Government boats	42	6,415.58
Barges	847	138,759.67
Small crafts	140	2,914.11
Rafts	260	.....
Total	2,326	257,076.29

Total number of lockages, 2,315.
The lock walls were submerged 49 days during the year.

Kind of craft.	Number.	Tonnage.
Lock No. 3, Green River.		
Passenger boats	493	79,564.78
Towboats	342	22,390.36
Government boats	61	9,428.24
Barges	613	110,665.22
Small crafts	106	908.24
Rafts	133	.....
Total	1,748	222,956.84

Total number of lockages, 1,685.
The lock walls were submerged 37 days during the year.

Kind of craft.	Number.	Tonnage.
Lock No. 4, Green River.		
Passenger boats	411	65,902.86
Towboats	781	30,055.23
Government boats	71	12,624.08
Barges	884	116,689.56
Small crafts	105	1,396.52
Rafts	39	.....
Total	2,291	226,668.25

Total number of lockages, 2,132.
The lock walls were submerged 24 days during the year.

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Statement of traffic passing the locks on Green and Barren rivers, etc.—Continued.

Kind of craft.	Number.	Tonnage.
Lock No. 1, Barren River.		
Passenger boats	257	44,785.99
Towboats	532	16,726.83
Government boats	52	9,348.88
Barges	553	52,081.18
Small crafts	84	495.35
Rafts	1	.....
Total	1,310	123,437.73

Total number of lockages, 1,310.
The lock walls were submerged 3 days during the year.

Statement of commerce passing the locks on Green and Barren rivers during the fiscal year ending June 30, 1893.

LOCK NO. 1, GREEN RIVER.

	Tons.		Tons.
Coal	236	Swine and sheep	843
Corn	520	Horses and mules	60
Wheat	310	Lumber	10,840
Salt	864	Timber	90,090
Oil	329	Staves	3,309
Whisky	17	Shingles	18
Flour	801	Ties, railroad	57,378
Sugar	577	Hoop poles	1,036
Molasses	157	Manufactured iron	144
Cement	754	Produce	16
Tobacco	1,033	General and miscellaneous	22,461
Hides	19		
Hay	473	Total	193,475
Cattle	1,200		

Number of passengers 10,128

LOCK NO. 2, GREEN RIVER.

	Tons.		Tons.
Coal	569	Cattle	522
Corn	501	Swine and sheep	487
Wheat	364	Horses and mules	54
Salt	915	Lumber	7,071
Oil	339	Timber	59,152
Whisky	23	Staves	4,462
Flour	689	Shingles	29
Sugar	495	Ties, railroad	63,626
Molasses	112	Hoop poles	835
Cement	956	Manufactured iron	102
Handles	232	Produce	15
Tobacco	841	General and miscellaneous	18,955
Hides	10		
Hay	485	Total	161,841

Number of passengers 6,686

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Statement of commerce passing the locks on Green and Barren rivers, etc.—Continued.

LOCK NO. 3, GREEN RIVER.

	Tons.		Tons.
Coal	308	Cattle	378
Corn	121	Swine and sheep	563
Wheat	61	Horses and mules	40
Salt	627	Lumber	2,338
Oil	112	Timber	25,512
Whisky	26	Staves	3,778
Flour	383	Shingles	14
Sugar	274	Ties, railroad	55,356
Molasses	105	Hoop poles	757
Cement	860	Manufactured iron	57
Handles	61	Produce	8
Tobacco	212	General and miscellaneous	16,803
Hides	5		
Hay	343	Total	109,107

Number of passengers 6,224

LOCK NO. 4, GREEN RIVER.

	Tons.		Tons.
Coal	19,853	Cattle	52
Corn	122	Swine and sheep	151
Wheat	62	Horses and mules	40
Salt	368	Lumber	2,733
Oil	130	Timber	11,255
Whisky	19	Staves	2,659
Flour	442	Shingles	6
Sugar	181	Ties, railroad	35,156
Molasses	33	Hoop poles	254
Cement	846	Manufactured iron	88
Handles	171	Produce	7
Tobacco	199	General and miscellaneous	9,722
Hides	2		
Hay	210	Total	84,761

Number of passengers 4,029

LOCK NO. 1, BARREN RIVER.

	Tons.		Tons.
Coal	18,527	Swine and sheep	44
Corn	57	Horses and mules	37
Wheat	15	Lumber	1,076
Salt	287	Timber	1,265
Oil	70	Staves	3
Whisky	6	Shingles	3
Flour	433	Ties, railroad	2,027
Sugar	151	Hoop poles	114
Molasses	23	Manufactured iron	50
Cement	49	Produce	2
Handles	117	General and miscellaneous	3,773
Tobacco	182		
Hay	151	Total	28,483
Cattle	21		

Number of passengers 2,942

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List of boats plying on Green and Barren rivers, Kentucky, during the fiscal year ending June 30, 1898.

Name of boat.	Character.	Length.	Breadth.	Draft.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Wm. Preston Dixon	U. S. snag boat	124.9	32	5	200
Col. G. L. Gillespie	U. S. towboat	110	25	3	82.50
Gayoso	Passenger	127.3	30	6	197.99
Evansville	do	121	30.2	5	194.24
Crescent City	do	121	30.2	5	194.24
C. B. Bryan	do				134.55
J. C. Kerr	do	120	25	4	125.97
Mary Stewart	do	100	20.6	3.6	90.20
Fawn	do	96	25	3.5	46
Lorna Doone	do	67	12.6	2.6	36.43
E. L. Reel	do	76	14	3	34.52
Jack Osborne	Towboat	136.6	30	4.6	188.51
Peter Honts	do	100	25	3.6	100
S. D. Blair	do				93.60
Longfellow	do	112	19.6	4.3	93.59
Troubadour	do	93.4	18	3	61.37
Little Tom Moss	do	90	22	3	56.30
I. N. Hook	do	109	19.4	3	55.95
Little Clyde	do	100	20	3.6	52.20
John T. Carson	do	85	18.8	3	47.60
J. B. Horton	do	65	14	4	36
Owensboro	do	80	18	3	35.54
Royal Pierce	do	70	17	3.3	29.18
Ida	do	60	14	3	22
Eleanor	do	60	16	2.8	14.64
Eureka	do	59	9	3	7.08
Isabella	Tugboat	95	22	4.8	66.24
Herbert Moran	do	94	16	6	51.98
Alice Barr	do	85	16	6	50.01
Blanche	do	92	17	3.8	48.40
Louisa	do	73	16.5	3.8	40.80
Hussar	do	80	15	4	39
Ingleside	do	81	14	4	36
Alfred Hennen	do	70	17	5	31.12
Edmund	do	56	12	3	14.54
Kalista	do	60	10	2.6	9.81
Lena Archer	do	45	9	4	8
Frank Von Behren	Sawmill	116	24	3	94
Little Charlie	do	120	24	3	82.21
Three Brothers	do	100	20	2.8	52.80
Charley Curlin	Pleasure	88.9	18	3	58.22
Mary Agnes	do	30	7.5	2.5	5.62
Sadie	do	31.5	6	4	3
Josephine	do	25	4	3	1
Repose	Gasoline	65	12	2.6	14
Richland	do	26	8.8	1.8	8.79
Janie Rae	Passenger	110	25.9	3	99.54
May Bell	Towboat				7.50

E E 10.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

For full report of project see page 2280, Report of Chief of Engineers for fiscal year ending June 30, 1896.

Operations during the past fiscal year were limited to a period of sixty-nine days' snagging and the construction of fence to inclose the lock grounds, as set forth in the report of Mr. D. A. Watt, Assistant Engineer, appended hereto.

The erection of a lock tender's cottage is contemplated and provided for in the approved project, but no further appropriation is deemed necessary at present, either for this purpose or for keeping the river clear of snags, etc., within the limits of the project.

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Money statement.

July 1, 1897, balance unexpended	$12,762.44
June 30, 1898, amount expended during fiscal year	1,687.95
July 1, 1898, balance unexpended	11,074.49
July 1, 1898, outstanding liabilities	17.27
July 1, 1898, balance available	11,057.22

Appropriations.

September 19, 1890	$25,000
July 13, 1892	15,000
August 18, 1894	22,500
June 3, 1896	43,000
Total	105,500

For commercial statistics see Lock and Dam, Rough River, Kentucky.

REPORT OF MR. D. A. WATT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations, under the appropriation for improving Rough River, Kentucky, during the fiscal year ending June 30, 1898.

The Wabash River snag boat has been engaged sixty-nine days during the year in removing obstructions from the channel of the river, in clearing the river banks of overhanging trees, and in cutting out stumps along the water's edge. The river has been cleared from Hartford, Ky., to its mouth. Three hundred and three snags and 404 stumps have been removed, and 559 trees cut or deadened. One thousand five hundred linear feet of wire fence has been built around the lock grounds on the lock side of the river.

The following is a statement of the expenditures during the year:

Labor	$1,302.59
Material	101.90
Fuel	20.01
Towing	25.00
	1,449.50

Very respectfully, your obedient servant,

D. A. WATT, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 11.

OPERATING AND CARE OF LOCK AND DAM IN ROUGH RIVER, KENTUCKY.

This lock and dam were built from funds provided in appropriations for improving Rough River, Kentucky, and opened to navigation December 12, 1896.

The first allotment for its operation and care under the indefinite appropriation was made July 23, 1897, and was as follows:

Salaries, regular employees	$2,011.00
Repairs, supplies, etc	75.00
	2,086.00

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In addition to the operation of the lock, the lock gates have been painted and the outbuildings whitewashed and the well on the lock grounds housed in by a small shed. Other details are given in the report of Mr. D. A. Watt, Assistant Engineer, appended hereto.

Detailed statement of expenditures made in connection with the work of operating and care of the lock and dam on Rough River, Kentucky, during fiscal year ending June 30, 1898.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
August	1	Pay roll	Services	$90.00
September	1	do	do	90.00
	2	Pesalee-Gaulbert Co	Red lead, etc	11.08
October	1	Pay roll	Services	90.00
November	1	do	do	90.00
December	1	do	do	90.00
1898.				
January	1	Pay roll	Services	90.00
February	1	do	do	90.00
March	1	do	do	45.00
	2	Sanford R. Ashby	do	8.00
	3	Roemer Bros	Shingles	1.80
April	1	Pay roll	Services	45.00
	2	Sanford R. Ashby	do	8.00
May	1	Pay roll	do	45.00
	2	Sanford R. Ashby	do	8.00
	3	Brown & Colburn	Capstan spindle	4.20
June	1	Pay roll	Services	45.00
	2	Sanford R. Ashby	do	8.00
		Total expended		859.08

REPORT OF MR. D. A. WATT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations pertaining to operating and care, etc., Rough River, Kentucky, during the fiscal year ending June 30, 1898.

In addition to the operation and care of lock, the following work has been done: The lock gates have been painted and the outbuildings whitewashed twice during the year, and a small house has been built over the well on the lock grounds.

Highest water occured January 30 and 31, 1898, the upper gauge reading 22.8 feet. Lowest water occured 113 days during the period from July 20 to November 26, 1897, inclusive, the upper gauge reading 6.0 feet. The lock walls were submerged 42 days during the year.

There is inclosed herewith a list of boats plying the river and a report of the traffic and commerce through the lock.

Very respectfully, your obedient servant,

D. A. WATT, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

STATEMENT OF TRAFFIC AND COMMERCE THROUGH LOCK NO. 1, ROUGH RIVER, KENTUCKY, FOR THE FISCAL YEAR ENDING JUNE 30, 1898.

TRAFFIC.

Kind of boat.	Number.	Tonnage.
Passenger	22	1,447.14
Tow	59	1,233.25
Government	1	72.00
Barges	70	4,173.30
Small craft	153	528.47
Rafts	178	.....
Total	483	7,454.16
Lockages	457	.....

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Statement of traffic and commerce through Lock No. 1, Rough River, Kentucky, etc.—Continued.

COMMERCE.

Articles.	Tons.
4,907 bushels coal	196
100 bushels corn	3
102 bushels wheat	3
266 barrels salt	37
85 barrels oil	17
17 barrels whisky	3
327 barrels flour	33
18 barrels sugar	3
7 barrels molasses	2
11 barrels cement	2
11,000 handles	16
7 hogsheads tobacco	6
500 bales hay	25
5 heads cattle	2
46,400 feet B. M. lumber	93
761,431 cubic feet timber	13,695
12,500 shingles	2
14,025 railroad ties	1,170
Manufactured iron	5
General and miscellaneous	175
Total	15,488

List of boats plying on Rough River, Kentucky, during the fiscal year ending June 30, 1898.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
Janie Rae	Passenger	110	25.9	3	99.54
Lorna Doone	do	67	12.6	2.6	36.43
E. L. Reel	do	76	14	3	34.53
Little Tom Moss	Towboat	90	22	3	56.30
Little Clyde	do	100	20	3.6	52.20
May Bell	do				7.50
Eureka	do	59	9	3	7.08
Alfred Hennen	Tugboat	70	17	5	31.12
Lena Archer	do	45	9	4	8
Three Brothers	Sawmill	100	20	2.8	52.80
Repose	Gasoline	65	12	2.6	14
Sadie	Pleasure	31.5	6	4	3

E E 12.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The Kentucky River was originally improved by the State of Kentucky, 1835–1839, by the construction of 5 locks and dams, the money having been furnished, it is said, by the bonds of the abutting counties issued under State authority and supervision. The system had for its object the completion of slack-water navigation to the coal fields near Beattyville, Ky., 261 miles above the mouth of the Kentucky, in the Ohio, at Carrollton, Ky. After the completion of these 5 locks, which carried slack water to Oregon, Ky., about 95 miles above the mouth, and during the construction of the sixth and seventh locks, barely commenced, the work was suspended owing to lack of funds. These locks, after many years of use, finally became useless through lack of care, and in 1879 the river was turned over to the United States with the supposed understanding that navigation would be maintained over that portion of the river already improved and the plan of further improvement continued. In 1879 Maj. W. E. Merrill, Corps of Engineers, United States Army, made an estimate for the repair of the

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existing locks and dams and for the extension of the slack-water system to Beattyville, Ky., by 12 additional locks and dams, at a total cost of $1,704,402. He also made estimates for the canalization of the three forks—North, Middle, and South (Annual Report of the Chief of Engineers, 1879, pp. 1398–1421). Of this project that portion only was approved providing for the canalization of the main stream to Beattyville, Ky. The estimate for this was increased in 1883 (Annual Report of the Chief of Engineers, 1883, p. 1561) to $2,471,639, providing, as before, for the repair of the 5 old locks and dams and the construction of 12 new ones. This is the present approved project.

After actual experience in the construction of Lock and Dam No. 6, Maj. D. W. Lockwood. Corps of Engineers, United States Army, estimated, under date of December 15, 1893, that the project of carrying slack-water navigation to Beattyville, Ky., could be effected by the construction of 9 additional locks and dams, at a cost of $2,740,782.30. This estimate was subsequently concurred in by Maj. James F. Gregory, Corps of Engineers, United States Army (Annual Report of the Chief of Engineers, 1896, p. 2287). Authority to change the estimate of 1883 has not, however, been given.

Since the submission of those revised estimates Lock and Dam No. 7 have been completed, giving further information on the subject of cost.

On March 17, 1898, in compliance with instructions contained in letter from the Chief of Engineers, dated March 1, 1898, I had the honor to submit a report showing what is required to complete the approved project for the improvement of Kentucky River, together with a revised estimate (based upon experience in the past few years) of the total cost of the project and the amount still required to complete it. The main features of this were as follows:

The total cost of Lock No. 7 up to June 30, 1898, is briefly stated as follows:

General expenses, including temporary buildings, office expenses, purchase and repair of plant	$37,055.37
Abutment	6,391.23
Lock	199,011.93
Dam	24,930.25
Upper land crib	1,607.44
Lower land crib	4,546.37
Triangular guide cribs	812.57
Grading grounds	9,948.40
General and closing work	2,297.87
Extra cost due to flood	4,167.29
Total	290,768.74

To this must be added the cost of lock-tenders' dwellings, about $5,600, and building roads and fences and laying paving on slope, estimated to cost about $5,000, making the total cost about $301,000, or practically the same as formerly estimated by Major Lockwood and Major Gregory. These officers, in their estimates previously referred to, have agreed that 8 locks and dams will be required above Lock No. 7 to complete the system, assuming an approximate lift of 15 feet for each, that being the average lift of those already constructed.

On the upper part of Kentucky River the banks are steeper and the lands less valuable than upon the lower portion, the river gorge having a ruling width of about 1,000 feet and steep, rocky sides, having a height above the river of from 200 to 300 feet. For that reason it is my opinion that there can be no valid objection to increasing this lift to 18 feet. The additional cost per lock for this increased height will not exceed $10,000, and by such increase nearly the entire cost of one lock can be

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saved, say $200,000. Beyond this there will be a saving of a year or more in the time of construction. Should this modification be approved there will be required 7 additional locks instead of 8, or 14 in all, counting those already built. These would be roughly located as follows (the levels run in 1884 by R. S. Burnett, assistant engineer, being assumed as sufficiently correct):

Lock No. 8, already located near Millers Creek, 23 miles above No. 7.
Lock No. 9, near Silver Creek, 11 miles above No. 8.
Lock No. 10, near Lower Howard Creek, 28 miles above No. 9.
Lock No. 11, near Drowning Creek, 29 miles above No. 10.
Lock No. 12, near Cow Creek, 16 miles above No. 11.
Lock No. 13, near Big Willow Creek, 23 miles above No. 12.
Lock No. 14, near Contrary Creek, 7½ miles above No. 13.

The reference of Pool No. 7 above the lower miter sill at Lock No. 1 (or supposed low water in the Ohio River) is 107.60. The river bed at Beattyville, Burnett's survey, is 213.20, or, adding 6 feet for navigable depth, 219.20. The total difference in level is therefore 111.6 feet. Seven dams, with a lift of 18 feet each, will provide for a difference of level of 126 feet, which would give ample depth at Beattyville.

The cost of these locks can not be estimated with exactness, owing to difficulties in transportation. Many of them must be built at a distance from railroads, and unless they are built successively so that each lock may be built after the next lower one is completed and slack water obtained, the transportation of materials and supplies will be difficult and expensive.

Assuming the cost of the lock, under conditions the same as when Lock No. 7 was built, at $301,000, the additional cost for extra lift at $10,000, the average cost of extra transportation at 50 cents per yard for stone and 50 cents per thousand for lumber, the lock would cost $319,000. To this must be added the cost of land for site of lock and abutment, about $2,500 for each lock, the cost of surveys and levels, amounting to about $1,500 for each lock, and the cost of deadening overhanging timbers on the banks and clearing the river bed of rocks and snags, about $3,000 for each pool. This brings the average cost of each lock up to $326,000, or for 7 locks $2,282,000, to which 12½ per cent should be added for office expenses, engineering, and contingencies, making the total amount for 7 locks and dams $2,567,250.

This estimate assumes the locks to be built under the same conditions as applied at Lock No. 7, viz, by hired labor and use of Government plant. No allowance has been made for contractor's profit or insurance.

To complete the approved project of 1883, calling for 8 more locks and dams, each with a lift of 15 feet, would, in my opinion, require $2,844,000, made up as follows:

Cost of Lock and Dam No. 7	$301,000
Average cost of transportation of material	8,000
Purchase of site	2,500
Surveys, each lock	1,500
Snagging and dredging	3,000
Cost of each lock	316,000
A. For 8 locks, at $316,000 each	2,528,000
Add 12½ per cent for office and engineering expenses and contingencies	316,000
Total for 8 locks	2,844,000

If the lift of the locks to be built is increased to 18 feet each, the estimated cost would be as follows:

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B. Seven locks with a lift of 18 feet each, at $326,000	$2,282,000
Twelve and one-half per cent for office and engineering expenses and contingencies	285,250
Total	2,567,250

I am, however, of the opinion that if these locks and dams are to be constructed by contract that, owing to difficulties of transportation, contractor's risk, etc., it will be safer to increase these estimates by 15 per cent, making them as follows:

C. Eight locks and dams, at $363,400 each	$2,907,200
Office and engineering expenses and contingencies	316,000
Total	3,223,200

With locks of 18-feet lift:

D. Seven locks and dams, at $374,900 each	$2,624,300
Office and engineering expenses and contingencies	285,250
Total	2,909,550

A summary of these estimates, showing total cost, amount appropriated to date, and amount required for completion, follows:

	Total cost.	Total appropriated to date.	Amount required for completion.
A	$4,800,000	$2,306,000	$2,494,000
B	4,523,250	2,306,000	2,217,250
C	5,179,200	2,306,000	2,873,200
D	4,865,550	2,306,000	2,559,550

Under date of May 27, 1898, the Chief of Engineers approved the plans and specifications for Lock No. 8, which provide for a lift of 18 feet.

These figures show that the total cost to the United States for this improvement, when completed, will have been $4,865,550, of which amount $1,750,363.58 has been expended.

The work completed, the annual cost of operation and maintenance will not be less than $7,500 per lock, or for 14 locks, $105,000.

* * * * * * *

As previously stated, the improvement was originated by the State for the development of the coal fields near Beattyville, Ky. As regards this coal, as far as I can learn from many inquiries, the deposits are quite extensive and of excellent quality, the veins from 3 to 4 feet thick, but irregular, often becoming so thin as to make it impracticable to work them to advantage. Several of these banks have been opened and coal shipped by river as far as Frankfort, Ky., but the high stage of water required to give the necessary draft rendered the running of coal barges dangerous, and the last coal sent down by barge was in 1894 to Big Hickman Creek. There is no positive information as to the extent of the coal deposit, as to the quality of the different veins, as to whether they would all pay to work, or as to the prospects of their being regularly worked by the respective owners.

There seems to have been no extensive prospecting carried on. Lands have been bought and some openings made to find the thickness of the veins and then operations suspended, the owners apparently preferring to wait until the extension of the slack-water system should reach their lands.

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At present the quantity of this coal mined is small, and is all shipped by rail, via the Lexington and Eastern Railway Company, to Lexington, Winchester, Versailles, Frankfort, Georgetown, Shelbyville, Richmond, and Paris, the greater part going to Lexington, to which point the freight rate is 90 cents per ton. The amount hauled during 1896 was 11,793 tons, 15,060 tons during 1897, and 6,726 tons during the first five months of 1898, not including that used by the railroad itself, which in 1896 was 4,249 tons, dropping to 297 tons in 1897, and to 140 tons during the first five months of 1898. The reason for this great decrease is that the railroad company now uses coal mined at Jackson, Ky., presumably on account of its lesser cost, though it is acknowledged to be of inferior quality.

Three companies are now mining and shipping coal, another will recommence in August, and one new company will begin operations in September. The amount now being shipped is about three carloads per week; during the past winter it was about three times as much.

I have made an effort to determine the comparative cost of this coal and the Pittsburg product, delivered at Carrollton, Ky., the point where the Kentucky River empties into the Ohio, but the results are unsatisfactory.

* * * * * * *

An inspection of the commercial statistics (see report for operating and care of locks and dams in Kentucky River for fiscal year ending June 30, 1898) shows no marked increase in the river traffic. Almost all the freight passed through Lock No. 7 since its completion has been either to or from the distillery at Camp Nelson, Ky., and included much coal from the lower river.

* * * * * * *

Plans and specifications have been prepared and approved for the construction of the lock-tenders' dwellings at Locks Nos. 7 and 8, for which bids are to be opened on July 6, and for the construction of the masonry of the lock walls and abutment of Lock No. 8 itself, to be opened July 28, 1898.

Titles to the site of Lock No. 8 and the abutment have been secured, and the deeds therefor properly recorded June 28, 1898, and June 29, 1898, respectively.

The details of the past year's operations are set forth in the accompanying report of Mr. J. M. G. Watt, Assistant Engineer.

The sum now available, $555,426.31, is sufficient for the economical prosecution of the work to June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$268,660.38
Amount appropriated by sundry civil act approved July 1, 1898	350,000.00
	618,660.38
June 30, 1898, amount expended during fiscal year	63,023.96
July 1, 1898, balance unexpended	555,636.42
July 1, 1898, outstanding liabilities	210.11
July 1, 1898, balance available	555,426.31
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	716,000.00

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Appropriations.

March 3, 1879	$100,000	June 3, 1896	$50,000
June 14, 1880	100,000	June 3, 1896	83,000
March 3, 1881	125,000	June 4, 1897	200,000
August 3, 1882	225,000	July 1, 1898	350,000
July 5, 1884	250,000		
August 5, 1886	187,500	Total	2,305,500
August 11, 1888	180,000	Received from Tabor & Cogar, October, 1888	500
September 19, 1890	180,000		
July 13, 1892	150,000	Total	2,306,000
August 18, 1894	125,000		

REPORT OF MR. J. M. G. WATT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of work done upon the improvement of the Kentucky River during the fiscal year ending June 30, 1898:

The work of the year was the continuation of the construction of the new lock and dam in the vicinity of Highbridge, Ky., being the seventh in the series now in operation.

The condition of work at the commencement of the fiscal year was briefly as follows: The abutment had been completed; a cofferdam constructed and excavated; the land wall of the lock completed, except part of the coping and wing walls, and the river wall completed up to course K; work on the gates had been commenced, and excavation next to the abutment for the dam had been begun.

The project under which the Kentucky River is undergoing improvement by the Federal Government was approved in 1879 (see Annual Report of the Chief of Engineers for 1879, pp. 1398–1421), and contemplated building locks and dams to carry slack water up to Beattyville, Ky., a distance of 261 miles, where it was supposed such large supplies of coal would be shipped to other places by water as to justify the expense of construction. The five lowest locks and dams were already built when this work was acquired from the State of Kentucky in 1880, but required extensive repairs. The sixth lock was completed in 1891 by the United States. The land for the seventh lock was acquired by the United States by condemnation after about two years' delay, and work was commenced in February, 1896, by shipping stone for the lock from Beattyville, Ky., about 5,000 cubic yards being transported. In April, 1896, the dredges were brought to the site of the lock and commenced excavation, which was carried on until June 7, when 37,340 cubic yards had been excavated. The cofferdam was begun March 29, 1896, and was closed June 7, 1896. It had a total length of 529 feet and a width of 12 feet, and consisted of a double row of piles, each row sheeted with Wakefield sheet piling, the whole thoroughly backed with gravel. Leakage through it was practically nothing. The cost of this cofferdam was $6,595.63, or about $12.42 per running foot, including bolts, backing, and all expenses. This coffer was pumped dry, and excavation of earth and rock was carried on from the inside, using four derricks which had been set up along the axis of the lock on platforms of piles driven before closing the coffer, and 12,403 cubic yards of earth and rock were removed, at a cost of $4,465.05, or 36.4 cents per cubic yard. During this excavation the abutment was commenced and completed. It is placed on and against solid rock. The excavation required was 9,040 cubic yards of earth, costing $1,608, or 20 cents per cubic yard, and 770 cubic yards of rock, costing $192.50, or 25 cents per cubic yard. In all, 383 cubic yards of masonry were placed in this abutment, at a cost for laying of $1.10 per cubic yard, or $16.70 per cubic yard including all expenses. The excavation was commenced May 15, 1896, and completed June 30, 1896. Masonry was commenced June 15, 1896, and completed June 30, 1896. The excavation for the lock within the cofferdam was completed by July 3, 1896, ready to lay the first stone, but a rise in the river flooded the cofferdam for more than two weeks, so that it was August 4, 1896, before laying stone could again be commenced. The foundation, consisting of 4,044 cubic yards, was commenced August 4, 1896, and completed August 20, 1896, at a cost of $35,286.72, or $8.75 per cubic yard in place. Laying the lock walls masonry was commenced August 21, 1896, and continued until October 8, 1896, when all work was stopped owing to lack of funds. This work was resumed May, 1897, and both walls were completed in September, 1897, with the exception of part of the wing walls, which were not finished until December 27, 1897. The gates were commenced June 1, 1897, and hung complete by August 30, 1897. All ironwork was placed during August and Septem-

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ber, 1897. Filling excavation behind lock wall and cribs was commenced on completion of the land wall and completed in April, 1898, requiring 50,717 cubic yards of earth, at a cost of 20.35 cents per cubic yard. A dam was commenced September 3, 1897, and completed November 6, 1897. In its construction 687,452 feet B. M. long-leaf yellow-pine timber was used and 12,189 cubic yards of stone ballast. The dam is 60 feet wide on the base and 351 feet long. The lowest step is 20 feet wide, is founded on rock, the remainder of the dam resting on the gravel bottom of the river.

The following is a short summary of the work done during the fiscal year ending June 30, 1898: The lock walls were completed, gates completed and hung, valves and operating irons placed, cofferdam torn out, dam commenced and completed, upper and lower river cribs and two upper guide cribs commenced and completed, entrances to lock dredged. The lock was ready for operation in November, but owing to extreme drought and low water in Pool No. 6 the first lockage was not made until December 11, 1897.

The following is a detailed statement of the work done during the fiscal year ending June 30, 1898:

LOCK.

Since the 1st of July, 1897, the following amount of stone was cut, at the cost shown:

Dressed face, 11 cubic yards, at $9.22 per cubic yard	$101.42
Pointed face, 173 cubic yards, at $7.03 per cubic yard	1,216.19
Quarry face, 46 cubic yards, at $4.01 per cubic yard	184.46
	1 502.07

Finished cutting stone September, 1897. From July 1, 1897, to December 27, 1897, when the last stone of the wing walls was set, 2,145 cubic yards of stone had been transferred from the stone yard and set in lock walls, including recesses for operating spars and a level pavement behind the land wall. The cost of masonry in the lock walls will be found in the tabulated statement herewith. The detailed cost of labor for setting pavement and recess masonry was as follows:

Pavement, 10 inches thick, 1,589 square feet:	
Labor in setting	$179.59
32 barrels Portland cement, at $2.70 per barrel	86.40
96 barrels sand, at 4 cents per barrel	3.84
	269.83

or an average of 17 cents per square foot.

RECESSES.

Cut 302 linear feet of quarry face and 103 square feet of pavement. Set 276 linear feet of quarry face, 276 feet of backing, 140 square feet backing, and 103 square feet of pavement.

COST OF RECESSES.

Labor, cutting stone	$145.07
Labor, setting stone	146.15
23 barrels Portland cement, at $2.70 per barrel	62.10
72 barrels sand, at 4 cents per barrel	2.88
	356.20

Nine recesses were cut in the land wall for line hooks and the hooks set. Six cast-iron snubbing posts were placed on land wall. The chamber faces of the lock walls were given two coats of linseed oil to resist absorption of water.

The cost of the lock masonry, including everything from coffer to finish, and allowing $14,694 as a fair proportion of "general expenses," was $14.544 per cubic yard. Details of cost will be found in tabulated statement herewith.

LOCK GATES.

Work was commenced on the lower lock gates June 1, 1897, and on the upper gates July 13, 1897. The leaves were framed on the bank, clamped up, fitted with all the irons, and then taken to pieces and transferred on August 20, 1897, to the lock pit, where they were rebuilt in position and connected to the anchor irons. They were completed and set up by August 30, 1897. Two wrought-iron swinging brackets were made and fitted on the outside wall to support the operating spars when the gates are open. Each spar was also fitted with a catch for holding gate open. Owing to the revised design of the gate-operating machinery, the gates can be opened by one man. The cost of the gates can be found below in the tabulated

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statement of cost. Each arm of these gates is formed of two pieces of yellow pine, 12 inches thick and 9 inches wide, making a gate 18 inches wide, keyed at ends with four oak keys, and having roofing paper between all abutting surfaces. Considering the extra labor in framing and in erection, it is recommended that in any future timber gate construction the arms be made of one stick 18 inches wide. This will give both a cheaper and stronger frame.

VALVES.

The lock is filled through culverts in the wall, the filling culvert discharging into the pit under the upper miter wall. The valves were made of wrought steel, instead of cast iron, as at Lock No. 6, and in many ways the construction here was notably improved over that of Lock No. 6. The system was so carefully designed that a man can open any wicket with one hand.

DAM.

The dam is a crib dam, built of 10-inch by 10-inch yellow pine throughout, filled with stone and sheeted on the up-stream face and slope with two rows of 3-inch and 2-inch timber. Its length is 351 feet, base width 60 feet, bottom step 20 feet, three other steps to crest each 10 feet wide; upstream slope 10 feet horizontal, 2 feet 9 inches vertical; the extreme height from bed rock to crest is 32½ feet. The lower step rests on solid rock, the remainder on the gravel bed of the river, here about 7 feet thick. The vertical height from crest of dam to the top step is 3 feet 9 inches; each of the other steps are 3 feet 4 inches high; the lift is 15½ feet, and the elevation of Pool No. 7 is 514.60 feet above mean sea level, or 107.60 feet above lower miter sill at Lock No. 1.

For the foundation of the bottom step there have been dredged in all 19,332 cubic yards of sand, gravel, and rock, at a cost of $2,174.11, an average of 11.24 cents per cubic yard. The timber work of the dam was commenced September 13, 1897, and finished November 6, 1897, the cost being as follows:

687,452 feet B. M. yellow-pine timber, at $16.40 per M	$11,274.21
Transporting timber, at $0.4740 per M	325.86
Spikes, at $0.7550 per M	519.01
Inspection of timber, at $0.2545 per M	175.00
Labor laying timber, at $2.4335 per M	1,672.66
	13,966.74

an average of $20.3170 per M feet B. M. in place.

A quarry has been opened on the United States land on the abutment side of the river, and 959 cubic yards of riprap quarried up to June 30, 1897. Since that date 11,230 cubic yards were quarried, making a total of 12,189 cubic yards, at a cost of $2,676.10, an average cost of 21.955 cents per cubic yard, distributed as follows:

Explosives, at 3.105 cents per cubic yard	$378.45
Illuminating, at 1.267 cents per cubic yard	154.43
Fuel, at .276 cents per cubic yard	33.62
Steel and repairs, at 1.006 cents per cubic yard	122.60
Labor, at 16.301 cents per cubic yard	1,897.00
	2,676.10

an average of 21.955 cents per cubic yard ready for loading on barges.

Began filling the dam with stone on September 17, 1897, and placed the last November 5, 1897. In all, 12,189 cubic yards of riprap were used, at a cost of $4,287.61, an average of 35.176 cents per cubic yard for the labor of loading on barges and unloading into dam, making a total average of 57.131 cents per cubic yard for the filling in place.

Began backing on dam September 27, 1897, and finished January 31, 1898, having placed 13,397 cubic yards of clay, gravel, and rock, at a cost of $1,825.69, an average of 13.627 cents per cubic yard.

The total cost of the dam was $24,930.25, an average inclusive cost of $36.265 per M feet B. M. of timber, or $71.026 per linear foot of dam, or, since the contents of the dam, on outside lines, are about 13,000 cubic yards, an average cost of $1.92 per cubic yard, complete.

UPPER LAND CRIB.

The upper land crib is 90 feet long, 16 feet wide on base, 8 feet on top, and about 22 feet high, and is built on 25 piles, with one 30-foot tie crib and one return crib at end 40 feet long. In the construction 15,505 feet B. M. of timber, that had been used as ties on the cofferdam, was utilized for the lower part of this crib. As this timber

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had been bought and used for the cofferdam, its cost is not figured in the total expense of the crib. Excavated for foundation from September 1 to 10, 1897, 923 cubic yards of earth, at 9.2 cents per cubic yard. Began laying timber September 3, 1897, and finished December 11, 1897; filled face of crib with stone carefully set flush with outside of crib; paved top of crib; set one ladder in face of crib; set 4 hitch rings and 4 check posts. Total cost was $1,607.44, an average of $28.875 per M feet B. M. complete.

UPPER GUIDE CRIBS.

Two triangular guide cribs were built, 24 feet on the face, with corners 5 feet wide. Between the lock and the first crib there is a space of 20 feet, and 30 feet between the two piers. Two wooden foot bridges connect the lower crib with the upper and with the lock. These bridges are 18 inches wide, and are attached by a strong chain to the crib. If the water rises above the top of the lock walls they simply float alongside the crib and are easily raised when the water has fallen a few inches below the lock wall. Construction of the cribs was commenced September 3, 1897, and completed November 9, 1897. The cribs are of 10-inch by 10-inch yellow pine, and rest on the gravel bottom about 2 feet below the level of the upper miter sill. The sides are carefully filled with stone set flush with the outer edge, and the top paved. One signal-light post was placed in position and four iron hitch rings. The whole cost was $812.63, an average of $35.578 per M feet B. M. of timber, complete.

LOWER LAND CRIB.

The lower land crib is 100 feet long, 22 feet wide at base, 10 feet at top, 39 feet high, with return crib 40 feet long and 2 tie cribs 30 feet long, and is founded on rock. It is built of 10-inch by 10-inch yellow pine timber throughout. Vertical sticks of 10-inch by 10 inch timber were bolted to the lock wall to act as a brace against earth pressure for the center stringer of the crib. Began excavation for foundation August 27, 1897, and completed it September 25, 1897, having removed, chiefly by derricks and dump boxes, 6,486 cubic yards of earth and clay, at a cost of 10 cents per cubic yard. Began laying timber September 27, 1897, and finished November 20, 1897. Filled crib from September 27, to December 1, 1897. Filled face of crib carefully with stone set flush with outside of crib, and paved top of crib. The total cost was $4,546.37, an average of $37.732 per M feet B. M. of timber, complete.

FILLING AND GRADING.

The earth slope at the foot of the cliffs on the lock side of the river has all been removed and used as filling behind the lock and cribs, and a ledge of rock with loose bowlders has been blasted out and used for the same purpose. Owing to a rise in December, 1897, which submerged the lock, a large quantity of the earth filling behind the lock wall and cribs was washed out, necessitating a refilling of about 6,000 cubic yards. During 1896 there were stripped from the quarry and wheeled out on the ground, for filling holes and inequalities, a total of 3,942 cubic yards of earth and stone, costing $864.32, an average of 21.926 cents per cubic yard; also handled 1,168 cubic yards of earth and stone for rebuilding roadway and washout at upper entrance to property at a cost of $415.80, an average of 36.30 per cubic yard.

Up to June 30, 1897, there had been dumped as filling behind land wall of the lock 2,530 cubic yards of earth and stone; during the fiscal year this was increased by 26,706 cubic yards, making a total of 29,236 cubic yards, costing $5,428.02, an average of 18.566 cents per cubic yard.

Since October 14, 1897, there have been placed as filling behind upper land crib 8,713 cubic yards of earth and stone, costing $1,726.22, an average of 19.812 cents per cubic yard, and behind the lower land crib 5,278 cubic yards, costing $1,020.31, an average of 19.332 cents per cubic yard.

At the lower end of the United States property there was a gully formed by the discharge of a spring; in this there was placed 2,082 cubic yards of earth and stone, costing $409.22, an average of 19.655 cents per cubic yard.

The total amount of filling behind lock, cribs, and in this gully is 50,419 cubic yards, at an average price of 19.564 cents per cubic yard.

Owing to the heavy rains in the early part of this year considerable of the filling has washed out from this gully and will have to be replaced this year, preferably with riprap, and the discharge from the spring will be conducted through a carefully built drain with an opening in the lower river crib.

GENERAL AND CLOSING WORK.

The general work was the usual work incidental to this class of construction, such as keeping all the plant in repair, sharpening tools, building and shifting railroad tracks and trestles, erecting and lowering derricks, and watching and caring for Government property.

In closing work for this season all the old buildings were torn down but one; the

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sides and ends of the traveling derrick were boarded up; all derrick masts, boom, and stiff legs were neatly stacked and a roof placed over them; stone cars were piled; a storehouse 100 feet by 24 feet was built and all movable property transferred to it and arranged in order and the different tools assorted; all the lumber was stacked; a new hull was built for the quarter boat and the top works transferred to it; one new barge was built and launched February 26, 1898; built wooden walk way around capstan on lock; repaired fences, gates, skiffs, wheelbarrows, and all other Government property.

LOCK HOUSES.

Plans and specifications for two lock houses, with cisterns and outbuildings, at Lock No. 7 and at site of Lock and Dam No. 8, were prepared during the winter, and advertisements issued for their construction by contract.

SITE OF PROPOSED LOCK AND DAM NO. 8.

A stadia survey of Pool No. 7, as far as Davis Creek, about 23 miles from Lock No. 7, with a line of levels, was begun on November 18, 1897, and finished December 13, 1897, and five approximate locations selected for proposed Lock No. 8. The two most favorable locations were carefully surveyed and platted, soundings were made, and other requisite information obtained, resulting in the selection of the location No. 4, a little above Millers Creek and below Napping and Towhead shoals, or 21.2 miles above Lock No. 7 and about 4¼ miles above Big Hickman Bridge. The land on both sides of the river was surveyed and temporary hubs placed at all corners. These will be replaced by permanent stone monuments. The titles to the land on both sides of the river have been obtained and the land purchased. Plans and specifications for the construction of the proposed lock were prepared during the winter.

Respectfully submitted.

JOHN M. G. WATT, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

Detailed statement of cost of construction of Lock and Dam No. 7, Kentucky River, Kentucky, including time from December 1, 1895, to June 30, 1898.

GENERAL EXPENSES.

Superintendence:	
General superintendence in field, inspectors, etc	$2,475.93
Office salaries, stationery, etc	1,565.41
Temporary buildings:	
Office	962.76
Oil house	183.60
Blacksmith shop	49.20
Storehouse for tools and machinery	255.36
Cement shed	185.90
Derricks:	
Framing, rigging, and raising 17 derricks	2,600.26
Rigging, tightening guy lines, oiling, and moving derricks	1,623.72
Tramways:	
Incline tramway, including tramway platform in coffer	1,039.68
Drum for lowering cars	106.40
Laying and relaying railroad track	939.14
Plant:	
New barges, repairs to derrick boats and barges	12,976.33
Addition to plant, new engines, wire rope, traveler, etc	9,489.69
Moving plant	1,951.99
Oil supplies for general purposes	650.50
	37,055.37

ABUTMENT.

Materials:	
192 barrels cement, at $1.07 per barrel	$205.44
50 cubic yards sand, at 28 cents per cubic yard	14.00
349 cubic yards stone, at $7.68 per cubic yard	2,680.32
34 cubic yards stone at $5.50 per cubic yard	187.00
Oil, dynamite, waste, etc	42.00
900 bushels coal, at 5 cents per bushel	45.00

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Labor:	
Raising 2 derricks	$69.30
Excavating 9,040 cubic yards earth, at 20 cents per cubic yard	1,808.00
Transporting 383 cubic yards stone, at 68 cents per cubic yard	260.44
Cutting stone	432.68
Laying 383 cubic yards stone, at $1.10 per yard	421.30
Moving plant	33.25
Excavating 770 cubic yards rock, at 25 cents per cubic yard	192.50
	6,391.23

LOCK.

Cofferdam:	
Royalty on 1,058 feet Wakefield triple-lap sheet piling, at 25 cents per foot	$264.50
3,680 linear feet piles, at 14¼ cents per linear foot	542.80
1,058 linear feet triple sheet piling, at $2.51 per linear foot	2,655.58
2,116 linear feet waling, 4 inches by 12 inches, at 7 cents per linear foot	148.12
1,560 pounds 16 feet iron rods, at 3½ cents per pound	54.50
1,036 linear feet tie pieces, at 9 cents per linear foot	93.24
Boat, spikes, and nails	136.90
Coal, coal oil, etc	120.00
Driving sheet and round piling	1,119.20
Carpenter work on waling, ties, etc	431.25
Filling and backing	1,029.44
Pumps:	
Setting up pumps and engines	1,043.71
Repairs to pumps and engines	550.12
Pumping cofferdam	983.25
Excavating:	
Dredging 44,386 cubic yards earth and sand, at 8.36 cents per cubic yard	3,710.67
Dug, wheeled, and hoisted out 19,158 cubic yards earth and sand, at 34.5 cents per cubic yard	6,609.51
Quarried, wheeled, and hoisted 4,788 cubic yards stone, at 41.5 cents per cubic yard	1,987.02
Mortar and filling joints:	
Quarried 1,180 cubic yards of spalls, at 41.8 cents per cubic yard	493.24
Dredged 2,730 cubic yards sand, at 17.3 cents per cubic yard	472.29
Handling cement and spalls, piping water, screening sand, mixing and handling mortar, at 24.054 cents per cubic yard	3,534.49
Inspection:	
Inspecting stone at Beattyville, Ky., at Lock No. 7, and at Salem-Bedford quarries, 15,888 cubic yards stone, at 13.60 cents per cubic yard	2,160.76
Inspecting 6,428 barrels cement, at 10.50 cents per barrel	674.94
Cement:	
Testing and storing cement	232.06
6,678 barrels "Diamond" cement, at $1.07 per barrel	7,145.46
1,210 barrels Saylor's Portland cement, at $2.58 per barrel	3,121.80
Cost of stone:	
Transported 4,559 cubic yards stone from Beattyville, Ky., at $7.68 per cubic yard	35,013.12
Purchased 1,809.48 cubic yards dressed face, at $13.90 per cubic yard	25,151.77
Purchased 8,534.73 cubic yards backing (freestone), at $5.50 per cubic yard	46,941.00
Purchased 487.69 cubic yards special, at $14.50 per cubic yard	7,071.50
Purchased 213.43 cubic yards coping, at $13 per cubic yard	2,774.59
Purchased 158.67 cubic yards coping, at $12 per cubic yard	1,904.04
Cutting stone:	
Cut 122.71 cubic yards, dressed face, at $9.227 per cubic yard	1,132.25
Cut 530.55 cubic yards thin backing, at $2.13 per cubic yard	1,130.07
Cut 509.63 cubic yards thick backing, at $1.83 per cubic yard	932.62
Cut 1,495.42 cubic yards, quarry face, at $4.015 per cubic yard	6,004.11
Cut 307.59 cubic yards, dressed face, cut to ladder ways, corners, etc., at $5.95 per cubic yard	1,830.16
Cut 355.84 cubic yards, pointed face, at $7.014 per cubic yard	2,495.86
Total, 3,321.74 cubic yards, average price $4.156 per cubic yard.	
Reduced ½ inch in bed joints 177 pieces, special	283.20

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Transferring stone to lock walls:	
Transferring 14,694 cubic yards stone to lock walls, at 31.80 cents per cubic yard	$4,672.73
Setting stone:	
Setting 14,694 cubic yards stone, at 88.234 cents per cubic yard	12,964.89
Iron work, etc.:	
Maneuvering irons, valves, etc	1,949.85
Labor of placing same	363.60
Pointing and cleaning flagging and lock walls	179.02
Cutting gauge	80.00
Fuel, oil, etc.:	
Fuel, including cost of storage and coaling engines	2,705.55
Coating lock walls with linseed oil	66.67
Sewer pipe for drain back of land wall	157.50
Gates:	
Paint, oil, etc	105.70
Transportation of timber	25.97
Timber, 57,569 feet B. M., at $16.40 per M	944.13
Tools, augers, etc	11.10
Roofing paper, etc	37.45
Iron and steel	634.16
Placing mud sills	21.25
Labor, framing and placing gates in position	2,113.22
	199,011.93

DAM.

Materials and labor:	
687,542 feet B. M. long-leaf yellow pine, at $16.40 per M	$11,274.21
Transportation of timber, at 47.40 cents per M	325.86
Spikes, 1,400 pounds, at $2.03 per hundredweight; bolts, 31,050 pounds, at $1.58 per hundredweight	519.01
Inspecting and receiving timber, at 25.45 cents per M	175.00
Laying timber, at $2.4335 per M	1,672.66
Dredging for foundation, 19,332 cubic yards, at 11.24 cents per yard.	2,174.11
Quarrying 12,189 cubic yards riprap, at 21.955 cents yer yard	2,676.10
Filling dam with riprap, 12,189 cubic yards, at 35.176 cents per yard.	4,287.61
Dumped as backing 13,397 cubic yards, at 13.627 cents per cubic yard.	1,825.69
	24,930.25

Dam is 351 linear feet, or an average of $71.026 per linear foot, or $36.265 per M feet B. M.

UPPER LAND CRIB.

Labor and materials:	
40,164 feet B. M. pine timber, at $16 per M	$642.62
Transportation of timber, at 48.14 cents per M	26.80
Spikes and bolts, at 76.028 cents per M feet B. M. of timber in dam	42.32
Laying timber, 55,669 feet B. M., at $3.275 per M	182.31
Excavating 923 cubic yards earth, at 9.2 cents per cubic yard	84.96
Quarrying 1,146 cubic yards riprap, at 23.6 cents per cubic yard	270.45
Filling in 1,146 cubic yards riprap, at 31 cents per cubic yard	357.98
	1,607.44

An average for 55,669 feet B. M., $28.875 per M.

TRIANGULAR GUIDE CRIBS.

Labor and materials:	
22,840 feet B. M. timber, at $16 per M	$365.44
Transportation of timber, at 58.67 cents per M	13.40
Spikes and bolts, at 92.64 cents per M feet B. M. of timber in crib	21.16
Laying timber, at $4.05 per M	92.50
Excavating 52 cubic yards earth, at 12 cents per cubic yard	6.24
Quarrying 663 cubic yards riprap, at 22.33 cents per cubic yard	148.05
Filling in 663 cubic yards riprap, at 25 cents per cubic yard	165.78
	812.57

An average of $35.578 per M feet B. M.

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LOWER LAND CRIB.

Labor and materials:	
120,489 feet B. M. timber, at $16 per M	$1,927.82
Transportation of timber, at 30.23 cents per M	36.43
Spikes and bolts, at 79.03 cents per M feet B. M. of timber in crib	95.22
Laying timber, at $1.28 per M feet B. M.	154.16
Excavating 6,486 cubic yards earth, at 10 cents per cubic yard	648.60
Quarrying riprap, 3,653 cubic yards, at 23.60 cents per cubic yard	862.11
Filling in riprap, 3,653 cubic yards, at 22.5 cents per cubic yard	822.03
	4,546.37

An average of $37.732 per M feet B. M.

GRADING GROUNDS.

Filling behind land cribs, lock wall, and gully in lower part of grounds, 50,419 cubic yards, at 19.564 cents per cubic yard	$9,863.89
Fencing grounds	84.51
	9,948.40

GENERAL AND CLOSING WORK.

Watching and caring for Government property, and operating lock from December, 1897, to June 30, 1898	$1,257.48
Storing machinery and plant, removing old buildings, etc	1,040.41
	2,297.89

EXTRA COST DUE TO FLOOD.

Repairing piling	$61.25
Placed 5,358 cubic yards backing, at 16 cents per cubic yard	859.63
Repairs to railroad track and platforms	70.71
Removing and replacing pumps, engines, tools, etc	216.11
Repairs to engines, pumps, etc	33.65
Removed 7,863 cubic yards mud deposit, at 26.2 cents	2,059.04
Fixed salaries during flood	866.90
	4,167.29

RECAPITULATION.

General expenses	$37,055.37
Abutment	6,391.23
Lock	199,011.93
Dam	24,930.25
Upper land crib	1,607.44
Triangular guide cribs	812.57
Lower land crib	4,546.37
Grading grounds	9,948.40
General and closing work	2,297.89
Extra cost due to flood	4,167.29
	290,768.74

E E 13.

OPERATING AND KEEPING IN REPAIR THE SEVEN LOCKS AND DAMS IN KENTUCKY RIVER, KENTUCKY.

The estimate and project for the operation and care of the completed locks and dams in this river during the fiscal year ending June 30, 1898, contained items which, summarized, are as follows:

Salaries (not including towboat and dredges)	$15,000.00
Repairs	22,550.00
Operating towboat	15,000.00
Electric plant	650.00
Steel derrick	675.00
Operating 2 dredges	8,000.00
Caring for 2 derrick boats	300.00
Total	62,175.00

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The first item provided for the payment of the salaries of the regular lock tenders at the several locks and a share of such expense in the district and local offices. The second for repairs to existing structures which had become so old and rotten or damaged as to render them unsafe, and for the ordinary current repairs incident to the operation of the locks and plant required to maintain the system in good navigable condition. The specific purpose of the other items is indicated by the wording of the items.

During the fiscal year Lock No. 7 has been completed with funds from "Improving Kentucky River, Kentucky," and opened to navigation December 11, 1897, and until the close of the year was operated by the watchmen caring for Government property stored at that point.

The details of the year's operations are set forth in the report of Mr. J. M. G. Watt, assistant engineer, appended hereto and followed by statements of traffic and commerce passing the locks.

Expenditures during the year were as follows:

Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, during the fiscal year ending June 30, 1898.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	1	Sundry persons	Services	$317.05
	2	.....do	.....do	27.87
	3	.....do	.....do	160.00
	4	.....do	.....do	886.33
	15	.....do	.....do	95.00
	16	.....do	.....do	95.00
	17	.....do	.....do	95.00
	18	.....do	.....do	95.00
	19	.....do	.....do	75.00
	20	.....do	.....do	29.25
	21	.....do	.....do	100.70
	22	.....do	.....do	106.70
	23	.....do	.....do	463.50
	24	.....do	.....do	204.83
	41	J. B. Smith	Traveling expenses	4.15
	42	M. A. Collins	Blue-grass seed	.45
	59	C. L. Caldwell	Beef	5.80
	60	Ellwanger Bros	Subsistence supplies, etc	110.51
	61	High Bridge Lumber Co	Lumber, etc	14.08
	62	M. A. Collins	Screen wire, etc	7.46
	63	M. P. Gray	Supplies	9.77
	64	S. J. Salyers	Beef	52.35
	65	The John Van Range Co	Linings	9.75
	66	Northern Lake Ice Co	Ice, etc	3.00
	67	H. J. Seppenfeld, jr	Subsistence supplies, etc	21.60
	68	John T. Buckley	Supplies	28.75
	69	The Postal Telegraph Cable Co	Toll on telegram	.22
	70	Smith & Corn	Subsistence supplies, etc	18.15
	71	The Ahrens & Ott Manufacturing Co	Brass cylinder	3.25
	72	The Consolidated Boat Store Co	Supplies	29.95
	75	.....do	Asbestus coating	9.15
	88	The Joseph R. Peeble's Sons Co	Subsistence supplies, etc	8.80
August	4	Sundry persons	Services	245.00
	13	.....do	.....do	160.00
	14	H. C. Bacon	.....do	20.25
	15	Sundry persons	.....do	95.00
	16	.....do	.....do	95.00
	17	.....do	.....do	95.00
	18	.....do	.....do	95.00
	19	.....do	.....do	95.00
	20	.....do	.....do	120.65
	21	.....do	.....do	439.50
	22	.....do	.....do	899.33
	40	.....do	.....do	75.00
	58	C. J. Comstock	Lumber	11.31
	70	John McGlothlin	Services	19.50
	76	Sundry persons	.....do	250.00
	77	.....do	.....do	160.00
September	1	Pay roll	.....do	839.67
	2	.....do	.....do	125.19
	3	.....do	.....do	100.83

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
September.	4	Pay roll	Services	$102.95
	5	....do	....do	124.89
	6	....do	....do	105.84
	7	....do	....do	108.61
	8	....do	....do	6.25
	9	....do	....do	463.50
	10	....do	....do	75.00
	11	J. G. Warren, captain, Corps of Engineers.	Mileage	8.80
	12	R. McKim & Co	Coal	448.00
	13	Ellwanger Bros	Subsistence supplies, etc	129.83
	14	Chas. Hegewald Co	Iron well, etc	86.69
	15	Crawley & Johnston	Castings, etc	78.17
	16	S. J. Salyers	Meat	41.33
	17	Geo. C. Payne & Co	Filter tube	3.00
	18	The Otis-Hidden Co	Stair plates	27.00
	19	Frankfort Elevator Coal Co	Coal	12.50
	20	Smith & Corn	Subsistence supplies, etc	94.87
	21	Gray & Stagg	Supplies	238.95
	22	W. L. Pence	Shingles	26.00
	23	Manning, Maxwell & Moore	Steam tubes	6.40
	24	Osgood Dredge Co	Spud shoes, etc	19.00
	25	Frankfort Ice Co	Ice	85.33
	26	H. J. Seppenfeld, jr	Subsistence supplies, etc	96.63
October	1	Pay roll	Services	887.50
	2	....do	....do	441.49
	3	....do	....do	160.00
	4	....do	....do	95.00
	5	....do	....do	95.00
	6	....do	....do	100.55
	7	....do	....do	48.70
	8	....do	....do	95.00
	9	....do	....do	132.95
	10	....do	....do	166.87
	11	The Cincinnati Railway Supply Co	Driftbolts	149.57
	12	The Cincinnati Marine Railway Co	Lumber	84.40
	13	H. J. Seppenfeld, jr	Subsistence supplies, etc	49.09
	14	Andrew J. Morse & Son	Diving dress	41.10
	15	John P. McGuire	Dipper teeth	30.00
	16	Fairbanks, Morse & Co	Scale	24.50
	17	Gray & Stagg	Supplies	9.03
	18	J. J. Black	Services of carpenter	9.00
	19	The Excelsior Laundry Co	Laundering	8.64
	20	S. J. Salyers	Beef	7.50
	21	The Globe Co	Hauling, etc	7.00
	22	S. T. Pence	Brackets	4.00
	23	High Bridge Lumber Co	Lumber, etc	3.42
	24	M. P. Gray	Rope, etc	3.11
	25	S. S. Mason	Hire of teamster and team	1.75
	26	Steamer Burnside	Transportation	1.00
	27	Adams Express Co	Expressage	.60
	28	J. G. Warren, captain, Corps of Engineers.	Mileage	8.40
	29	Cincinnati, New Orleans and Texas Pacific Rwy.	Transportation	3.10
	30	....do	....do	3.10
	31	T. J. Congleton & Bro	Timber, etc	206.39
	32	Smith & Corn	Subsistence supplies, etc	125.45
	33	W. L. Pence	Lumber, etc	73.26
	34	Adkinson Bros	Lumber	40.06
	35	Frankfort Ice Co	Ice	29.24
	36	H. C. Bacon	Traveling expenses	14.07
	37	John M. G. Watt	....do	8.73
November	1	Pay roll	Services	854.84
	2	....do	....do	358.87
	3	....do	....do	155.80
	4	....do	....do	257.96
	5	....do	....do	141.69
	6	....do	....do	844.23
	7	Geo. Sample	....do	13.33
	8	Pay roll	....do	79.50
	9	....do	....do	100.55
	10	....do	....do	195.00
	11	....do	....do	95.00
	12	....do	....do	20.10
	13	The Cincinnati Railway Supply Co	Spikes	23.28
	14	W. D. Hardin	Eggs, etc	15.41
	15	M. A. Vaughn	Milk	4.80
	16	John W. Sparks	Stone	24.50

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
November.	17	Gray & Stagg	Supplies	$108.24
	18	S. S. Collins	Jars, etc	8.97
	19	Frankfort Ice Co	Ice, etc	26.00
December..	1	Pay roll	Services	156.05
	2	....do	....do	271.00
	3	....do	....do	4.80
	4	....do	....do	824.19
	5	....do	....do	438.44
	6	....do	....do	205.00
	7	....do	....do	463.50
	8	....do	....do	95.00
	9	....do	....do	5.25
	10	....do	....do	95.00
	11	....do	....do	95.00
	12	....do	....do	13.05
	13	....do	....do	95.83
	14	....do	....do	95.00
	15	....do	....do	95.00
	16	....do	....do	7.50
	17	....do	....do	842.63
	18	C. H. Koster	Flags	28.70
	19	The American Forcite Powder Manufacturing Co.	Exploders	9.25
	20	Pay roll	Services	19.95
	21	H. C. Bacon, carpenter	Traveling expenses	9.25
	22	Wm. W. Harts, first lieutenant, Corps of Engineers.	Mileage	4.80
	23	....do	....do	4.00
	24	....do	....do	6.64
	25	Western Union Telegraph Co	Telegrams, etc	5.39
	26	Enterprise Lumber Co	Timber	4,430.02
	27	The Western Union Telegraph Co	Toll on telegrams, etc	.70
	28	....do	Toll on telegrams	.49
	29	....do	Telegrams	.76
	30	Frankfort Elevator Coal Co	Coal	194.09
	31	Frankfort Ice Co	Ice	18.75
	32	Church Bros	Team hire	4.00
	33	S. J. Salyers	Beef	33.98
	34	John M. G. Watt, assistant engineer and draftsman.	Traveling expenses	20.50
	35	Howard & Noonan	Subsistence supplies	31.98
	36	Pay roll	Services	62.23
	37	Smith & Corn	Subsistence supplies, etc	136.14
	38	O. M. Wood & Son	....do	80.77
	39	Gray & Stagg	Supplies	297.17
	40	Howard & Noonan	Subsistence supplies	22.60
	41	Gray & Stagg	Supplies, etc	245.27
	42	John Barrett & Son	Coal	284.28
	43	Standard Oil Co	Oil	15.38
	44	G. W. Lawrence & Co	Coal	29.50
	45	Pay roll	Services	617.50
	46	M. A. Vaughn	Milk, etc	1.80
	47	J. N. Roberts	Lumber	31.33
1898.				
January...	1	Pay roll	Services	806.50
	2	....do	....do	419.50
	3	....do	....do	95.00
	4	....do	....do	25.10
	5	....do	....do	186.20
	6	....do	....do	133.79
	7	....do	....do	95.00
	8	....do	....do	95.00
	9	....do	....do	95.00
	10	....do	....do	95.00
	11	....do	....do	95.00
	12	....do	....do	4.80
	13	John M. G. Watt	....do	85.00
	14	Theodore Wylie	....do	120.00
	15	H. C. Bacon	....do	9.00
	16	P. M. Bess, master mason	Traveling expenses	12.38
	17	Pay roll	Services	832.47
	18	....do	....do	126.85
	19	James Heeney	Subsistence supplies, etc	148.39
	20	Adkinson Bros	Lumber	20.03
	21	Ellwanger Bros	Subsistence supplies, etc	55.48
	22	H. J. Seppenfeld, jr	Beef	24.93
	23	Gray & Stagg	Supplies	151.38
	24	J. W. Davis Coal Co	Coal	43.54
	25	Enterprise Lumber Co	Transferring lumber	268.48

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
January...	26	Rand Drill Co	Bushing	$2.11
	27	The American Forcite Powder Manufacturing Co.	Exploders	9.25
	28	The Western Union Telegraph Co	Telegrams	2.90
	29	John T. Buckley	Galvanized iron, etc	14.75
	30	Gray & Stagg	Supplies	152.47
	31	Frankfort Ice Co	Ice	21.75
	32	John O'Conners	Services	3.50
	33	W. Dugan	do	19.83
	34	Pay roll	do	73.30
	35	do	do	6.90
	36	J. G. Warren, captain, Corps of Engineers.	Mileage	2.60
	37	S. J. Salyers	Beef	40.64
	38	J. R. Craigmyle	Butter	2.10
	39	Courier-Journal Job Printing Co	Supplies	41.50
	40	T. J. Congleton & Bro	Lumber, etc	93.22
	41	W. H. Parrish	Lumber	11.39
	42	Joel Payne	Milk	6.90
	43	Peaslee-Gaulbert Co	Metal polish	16.20
	44	Pay roll	Services	270.00
February..	1	do	do	927.82
	2	do	do	794.77
	3	do	do	224.38
	4	do	do	416.20
	5	do	do	67.55
	6	do	do	72.32
	7	do	do	95.00
	8	do	do	95.00
	9	do	do	95.00
	10	do	do	95.00
	11	do	do	95.00
	12	do	do	95.00
	13	W. P. Frost	Milk, etc	6.32
	14	Postal Telegraph Cable Co	Telegram	.20
	15	Wm. W. Harts, first lieutenant, Corps of Engineers.	Mileage	5.20
	16	John Dunaway	Services	28.00
	17	James Shearer	do	16.50
	18	Jos. Shearer	do	16.50
	19	Geo. Spaulding	do	4.35
	20	James Buckley	do	3.30
	21	Adams Express Co	Express charges	1.50
	22	S. J. Salyers	Beef	22.72
	23	Jas. Clark, jr., & Co	Rewinding armature	30.00
	24	J. W. Davis Coal Co	Coal	493.84
	25	D. Lyon Skiff Co	Skiff, etc	20.00
	26	M. A. Vaughn	Milk	2.30
	27	Chas. Hegewald Co	Capstan spindle	5.00
	28	Frankfort Ice Co	Ice	15.50
	29	James Heeney	Subsistence, etc	158.39
	30	Holmes & Baird	Apollinaris water	4.58
	31	T. B. Ripy	Coal	7.00
	32	M. A. Vaughn	Subsistence supplies	5.10
	33	Gray & Stagg	Supplies	48.37
	34	The Western Union Telegraph Co	Telegrams	5.21
	35	do	Telegram	.27
	36	F. C. Nunemacher	Blank books, etc	39.45
	37	Frederick Diehl	Stationery, etc	14.99
	38	Chas. E. Beecher	Rubber stamps, etc	5.45
	39	Louisville and Nashville R. R. Co	Transportation	3.44
	40	Pullman's Palace Car Co	do	.50
	41	Louisville and Nashville R. R. Co	do	1.90
	42	Cincinnati New Orleans and Texas Pacific Rwy.	do	.65
	43	Pay roll	Services	270.00
	44	Wm. W. Harts, first lieutenant, Corps of Engineers.	Mileage	13.04
March.....	1	T. J. Congleton & Bro	Lumber	10.65
	2	Black & Hoge	Coal	108.18
	3	Cincinnati, New Orleans and Texas Pacific Rwy. Co.	Transportation	2.50
	4	Pay roll	Services	903.33
	5	do	do	342.24
	6	Geo. Spaulding	do	4.80
	7	Pay roll	do	241.70
	8	do	do	95.00
	9	do	do	95.00
	10	do	do	95.00
	11	do	do	95.00

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
March.....	12	Pay roll.....	Services.....	$95.00
	13	.....do.....	.....do.....	9.00
	14	.....do.....	.....do.....	76.41
	15	.....do.....	.....do.....	96.50
	16	.....do.....	.....do.....	19.20
	17	.....do.....	.....do.....	182.59
	18	.....do.....	.....do.....	76.52
	19	Pullman's Palace Car Co.....	Transportation.....	3.00
	20	Pay roll.....	Services.....	88.33
	21	Gray & Stagg.....	Supplies.....	89.64
	22	James Heeney.....	.....do.....	129.17
	23	M. A. Vaughn.....	Milk.....	1.80
	24	Frankfort Ice Co.....	Ice.....	13.75
	25	H. J. Seppenfeld, jr.....	Supplies.....	164.44
	26	A. B. Donaldson.....	Milk.....	4.80
	27	The Cincinnati Tin and Japanning Co	Lamps, etc.....	22.20
	28	Pay roll.....	Services.....	16.50
	29	The Drummond Manufacturing Co...	Castings, etc.....	62.31
	30	W. W. Hite & Co.....	Oakum.....	32.50
	31	Pay roll.....	Services.....	270.00
April.....	1	.....do.....	.....do.....	209.16
	2	.....do.....	.....do.....	238.00
	3	.....do.....	.....do.....	247.00
	4	.....do.....	.....do.....	100.40
	5	.....do.....	.....do.....	95.00
	6	.....do.....	.....do.....	95.00
	7	.....do.....	.....do.....	95.00
	8	.....do.....	.....do.....	95.00
	9	.....do.....	.....do.....	95.00
	10	Chas. C. Stoll Oil Co.....	Linseed oil.....	19.95
	11	Chas. L. McKee, time-keeper.....	Traveling expenses.....	8.77
	12	A. B. Donaldson.....	Stone.....	72.00
	13	Standard Oil Co.....	Oil.....	20.33
	14	H. J. Seppenfeld, jr.....	Beef.....	11.52
	15	James Heeney.....	Supplies.....	33.26
	16	Frankfort Ice Co.....	Ice.....	6.00
	17	Gray & Stagg.....	Supplies.....	54.96
	18	.....do.....	.....do.....	37.09
	19	Wingate Thompson, master laborer...	Traveling expenses.....	5.45
	20	Perry McKim.....	Milk.....	7.80
	21	Milton W. Barkhouse.....	Asbestus cement.....	3.20
	22	W. H. Neill.....	Supplies.....	29.11
	23	Peaslee-Gaulbert Co.....	Red lead.....	29.60
	24	The Todd-Donigan Iron Co.....	Supplies.....	19.10
	25	Peaslee-Gaulbert Co.....	Tumblers, etc.....	3.66
	26	W. B. Belknap & Co.....	Supplies.....	6.10
	27	Ben Meeker.....	Services.....	7.20
	28	Frederick Diehl.....	Supplies.....	46.85
	29	The Laidlaw-Dunn-Gordon Co.....	Steam pump.....	60.00
	30	Kentucky River Packet and Towboat Co.	Freight charges.....	4.50
	31	Leonard & Ellis.....	Oil.....	17.85
	32	The Cincinnati Railway Supply Co...	Sheaves.....	3.15
	33	Gray & Stagg.....	Supplies.....	47.89
	34	Ed. J. Howard.....	Timber.....	288.19
	35	Pay roll.....	Services.....	800.00
	36	.....do.....	.....do.....	270.00
May.....	1	.....do.....	.....do.....	655.18
	2	James Heeney.....	Supplies.....	5.48
	3	Pay roll.....	Services.....	250.00
	4	.....do.....	.....do.....	265.00
	5	.....do.....	.....do.....	95.00
	6	.....do.....	.....do.....	95.00
	7	.....do.....	.....do.....	95.00
	8	.....do.....	.....do.....	95.00
	9	.....do.....	.....do.....	104.00
	10	.....do.....	.....do.....	100.70
	11	Chas. Hegewald Co.....	Outfit.....	54.00
	12	Pay roll.....	Services.....	27.60
	13	Geher & Son.....	Supplies.....	21.72
	14	Troxell Bros.....	Asbestus.....	28.81
	15	T. J. Congleton & Bro.....	Lumber.....	2.34
	16	Phil A. Vogel & Sons.....	Supplies.....	57.48
	17	Kentucky River Packet and Towboat Co.	Freight charges.....	.25
	18	Gray & Stagg.....	Supplies, etc.....	398.79
	19	W. W. Hite & Co (Incorporated).....	Oakum.....	19.50
	20	Henry Vogt Machine Co.....	Towing knees, etc.....	106.00
	21	Indiana Forge and Rolling Mill Co...	Iron.....	6.50
	22	W. B. Belknap & Co.....	Supplies.....	4.40

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Detailed statement of expenditures made in connection with the work of operating and care of the locks and dams on Kentucky River, Kentucky, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
May	23	A. Button & Son	Subsistence supplies	$8.97
	24	McKibbin Bros	do	33.90
	25	Joseph P. Lynch, clerk	Traveling expenses	7.55
	26	Gray & Stagg	Supplies	57.95
	27	Arthur Kaye	Tableware	30.07
	28	Milton W. Barkhouse	Supplies	46.05
	29	Pay roll	Services	270.00
	30	Albrecht & Heick	Butts, hooks and eyes, etc	.94
June	1	Pay roll	Services	554.28
	2	do	do	245.00
	3	do	do	265.00
	4	do	do	95.00
	5	do	do	95.00
	6	do	do	95.00
	7	do	do	95.00
	8	do	do	95.00
	9	do	do	100.40
	10	J. G. Warren, captain, Corps of Engineers.	Mileage	4.24
	11	Pay roll	Services	7.50
	12	Theodore Wylie, clerk	Traveling expenses	3.55
	13	Phil A. Vogel & Sons	Supplies	60.42
	14	James Heeney	Subsistence supplies	6.95
	15	Courier-Journal Job Printing Co	Paper	6.00
	16	Leavenworth Skiff Co	Skiff, etc	24.50
	17	M. A. Vaughn	Milk	2.20
	18	Chas. Hegewald Co	Chocks, etc	17.00
	19	Northern Lake Ice Co	Ice	5.60
	20	Albrecht & Heick	Wire, etc	17.60
	21	Louisville Bridge and Iron Co	Steel derrick	190.00
	22	Fewlass Brass and Iron Works	Siphon couplings	16.80
	23	Ed. J. Howard	Lumber, etc	371.94
	24	Gray & Stagg	Supplies	43.16
	25	David Welsh	Bath tub, etc	76.00
	26	W. B. Belknap & Co	Supplies	40.30
	27	Standard Oil Co	Oil	3.31
	28	Imperial Laundry	Laundering	2.94
	29	A. Button & Son	Subsistence	23.94
	30	Peaslee-Gaulbert Co	White lead, etc	14.34
	31	Bridges-Strassel Co	Glass	1.68
	32	The Chas. Barnes Co	Dredge parts	78.20
	33	Arthur Kaye	Toilet sets	7.50
	34	W. B. Belknap & Co	Screen wire, etc	2.40
	35	Pay roll	Services	270.00
	36	do	do	826.67
	37	Geher & Son	Covering posts, etc	74.80
	38	Leonard & Ellis	Oil	35.88
	39	Osgood Dredge Co	Dredge parts	45.00
	40	S. S. Collins	Ice	3.29
	41	Courier-Journal Job Printing Co	Job printing	3.50
	42	Gray & Stagg	Supplies	125.43
	43	W. W. Hite & Co. (Incorporated)	Life belts	19.20
		Total expended		49,084.03

Allotments for fiscal year ending June 30.

1885	$15,000.00	1893	$40,503.62
1886	24,000.00	1894	73,065.02
1887	35,133.60	1895	46,435.28
1888	82,308.54	1896	59,120.04
1889	82,478.50	1897	70,198.85
1890	72,394.80	1898	42,272.11
1891	28,889.07		
1892	48,826.68	Total	720,626.11

REPORT OF MR. J. M. G. WATT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 30, 1898.

CAPTAIN: I have the honor to submit herewith the following report concerning the operating and care of locks and dams used in the navigation of the Kentucky River, Kentucky, during the fiscal year ending June 30, 1898.

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During the past year the river was open to navigation for 327 days. On account of low water, resulting from extreme drought, navigation was practically suspended above Lock No. 4 from October 10 to November 10, 1897, and in the upper part of Pool No. 5 until December 14, 1897. On account of high water navigation was suspended at the lower end of the river (chiefly from backwater from the Ohio River) during January nineteen days, February twelve days, and April seven days; at the upper end of the river for three days in January, 1898.

The river during the past autumn has been unusually low, no water coming into the various pools from the creeks and branches, and the water from the head being cut off by the dam then being constructed at Lock No. 7; but, owing to the tightness of the dams, there has always been enough water for navigation up to Lock No. 4.

One wire-cable ferry line has been established about 1 mile above Carrollton, Ky., and a second one about a mile farther upstream, both under authority of the Secretary of War.

A new transportation line was put in operation during the year between Cincinnati, Ohio, and Frankfort, Ky.—the Cincinnati Mail Line Company, steamer *Dick Brown*. The dumping of refuse from stables and sawmills into the river or on the banks where it might be carried off by high waters has been stopped.

The main features of the work of repairs and preservation during the past year have been as follows: The dam at Lock No. 1 has been partially backed with gravel and stone. The river crib at lower end of lock has been torn out and a new one built and filled. At Lock No. 2 the lower slope of the dam has been repaired, the dam partially backed with stone, the abutment repointed, and the abutment cribs filled with stone. At Lock No. 3 the abutment has been repointed, the abutment cribs filled with stone, the river crib at lower end of lock torn out, and a new one built and filled with stone. At Lock No. 6 a triangular guide crib has been built and partially filled with stone.

During the year all locks were kept in good working order and all Government property cared for; all outbuildings and fences were whitewashed; vegetation destroyed from slope walls, cribs, and walks; lock entrances were kept free from drift and mud; all lock gates and operating irons were painted and all lock houses put in a good state of repair inside; flagstaffs, 48 feet in height, were erected at each lock.

The following is a detailed statement of work done:

LOCK NO. 1.

Dam.—The dam has been backed with 1,205 cubic yards of gravel to stop leaks. The old and defective sheeting was removed and replaced with new sheeting.

Lower river crib.—Finished tearing out lower river crib and replaced it with a new crib 120 feet long; base width, 18 feet; top width, 14 feet; height, 35 feet, and filled it with stone.

General work.—A shed was built over hoisting engine; the walls of the lock house were repaired; a coal house, 11½ by 14 feet, was built.

The last annual estimate carried a sum for rebuilding the timber abutment crib and for building a stone abutment. No work was done under these items, and it is not now proposed to do any, in view of the fact that the dam may have to be rebuilt within the next three years, in which case the location would be moved upstream of the present dam. When this shall be done, then a masonry abutment and timber cribs can be built at the same time and at a less expense.

The highest water occurred March 30, 1898, upper gauge reading 39.1 feet. The lowest water occurred October 29, 1897, upper gauge reading 5.3 feet; lower gauge, 4.1 feet. The walls of the lock were submerged thirty-nine days during the year.

LOCK NO. 2.

Dam.—The slope sheeting for a distance of 75 feet was removed; 41 new range sticks 10 by 10 inches placed; 103 pieces of 3-inch, 186 pieces of 6-inch, and 118 pieces of 9-inch sheeting replaced, using 2,908 drift spikes and 52 bolts.

Abutment.—The old and defective stone near the top was removed and replaced by fresh stone; 35 cubic yards of stone were set as coping, raising the level of the abutment about 4 feet; the front of the abutment was repointed. The cost was as follows:

Labor	$175.23
Materials:	
20 barrels Portland cement, at $2.85 per barrel	57.00
35 cubic yards stone, at $5.50 per yard	192.50
Total	424.73

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Abutment cribs.—Six pieces of timber were torn from the upper crib and the crib raised 4 feet to the new level of the abutment by the addition of 16 pieces of timber 6 inches by 12 inches by 12 feet, and 18 pieces 10 inches by 10 inches by 30 feet, using 134 driftbolts and filling with 57 cubic yards of riprap. The filling of the lower river crib was finished by the addition of 1,149 cubic yards of riprap and that of the abutment by 441 cubic yards of riprap.

Quarry.—Quarrying tools were transported from Lock No. 7 to this site; a quarry was opened for supplying the stone filling for cribs at Locks 2 and 3; stripped 783 cubic yards of earth, and quarried and sledged 6,130 cubic yards of riprap, at an average cost of 72.84 cents per cubic yard. The following is a statement of cost:

Labor:	
Superintendence	$318.50
Blasting riprap, steam drillers, engineers, etc.	730.53
Sledging and handling riprap from quarry to river bank	2,803.13
Materials: Dynamite and supplies	613.20
	4,465.36

Detailed cost:

Cost of explosives, $304.17, or about 4.96 cents per cubic yard.

Total cost of supplies, including explosives, $613.20, or about 10 cents per cubic yard.

Superintendence, salaries of master laborers, etc., $318.50, or about 5.2 cents per cubic yard.

Cost of quarrying riprap, exclusive of superintendence, $730.53, or about 11.92 cents per cubic yard.

Sledging and handling riprap from quarry to river bank, $2,803.13, or about 45.72 cents per cubic yard.

Total cost of riprap, sledged and on river bank ready to transport, $4,465.36, or about 72.84 cents per cubic yard.

General work.—Built check posts in upper land crib and painted same.

The highest water occurred January 24, 1898, upper gauge reading 33.7 feet; the lowest water occurred October 30, 1897, upper gauge reading 6.8 feet, lower gauge 3.2 feet. The walls of the lock were submerged twenty-eight days during the year.

LOCK NO. 3.

Dam.—Removed old and defective sheeting from dam and replaced with 3,952 feet B. M. new oak sheeting.

Abutment.—The whole face of the abutment above pool level, amounting to 2,233 linear feet, has been repointed at a cost of $37.05 for cement and $183.68 for labor, a total cost of $220.73. The abutment crib was filled with 555 cubic yards of riprap.

Lower river crib.—The lower river crib was torn out and replaced with a new crib 80 feet long, base width 18 feet, top width 13 feet, height 33 feet. This crib was filled with 2,902 cubic yards of riprap quarried at Lock No. 2.

Triangular crib.—The upper triangular crib was torn out, but has not yet been replaced.

Lock.—Repaired sheeting in lower gates; made bridge from lock to upper river crib.

General work.—Repaired fence damaged by high water; built and painted porches, 20 feet by 6 feet, at the rear of each lock house.

The highest water occurred January 23, 1898, upper gauge reading 23.4 feet; the lowest water occurred October 29, 1897, upper gauge reading 4.9 feet, lower gauge 5.7 feet. The walls of the lock were submerged three days during the year.

LOCK NO. 4.

Dam.—Removed defective sheeting and replaced with 60 pieces of oak sheeting 9 inches by 12 inches by 10 feet; laid one new range stick 10 inches by 12 inches by 14 feet; replaced filling in six pens of dam; stopped leak behind dam with riprap.

General work.—Repaired lock house and flashings on porches; built dust-proof closet in storehouse, 10 feet by 12 feet, for storing blankets, etc.

The highest water occurred January 24, 1898, upper gauge reading 23.9 feet; lowest water occurred October 31, 1897, upper gauge reading 3.3 feet, lower gauge 2.4 feet. The walls of the lock were submerged three days during the year.

LOCK NO. 5.

Dam.—Placed behind dam as backing to stop leaks 680 cubic yards of clay and gravel.

General work.—Placed new capstan shaft in position in capstan on lock wall; papered one room of lock master's house; repaired basement of lock hands' house.

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The highest water occurred January 23, 1898, the upper gauge reading 23 feet; the lowest water occurred October 31, 1897, upper gauge reading 1.6 feet, lower gauge 3.3 feet. The walls of the lock were submerged three days during the year.

LOCK NO. 6.

Triangular guide crib.—Built one new triangular guide crib and filled it two-thirds with riprap.

Lock.—Repaired the wooden sill at lower gate and repainted it during the extreme low water, and stopped leaks; set new gear wheels and capstan plates for gate machinery.

General work.—Repaired pump on lock wall; painted walls of kitchens in lock houses.

The highest water occurred January 23, 1898, upper gauge reading 23.1 feet; the lower pool was below the level of the lower miter sill from October 19, 1897, to November 11, 1897 (drawn down for the construction of Dam No. 7). The lowest water in the upper pool was from November 25, to December, 3, 1897; the upper gauge reading 0.9 feet. The walls of the lock were submerged two days during the year.

U. S. TOWBOAT GEN'L O. M. POE.

The U. S. towboat *Gen'l O. M. Poe* was in active service until March 8, 1898, when she went into ordinary at Louisville, Ky., and underwent extensive repairs at the Louisville and Portland Canal Dry Dock, consisting of renewal of deck timbers and other worn or deteriorated woodwork; a new after mud drum, furnaces, etc., and a thorough overhauling of machinery and steam pipes. The old wheel shaft having developed a dangerous crack, a new steel shaft with flanges was purchased and put in place, and the woodwork of the wheel renewed. With the exception of the boom, the old wooden derrick was replaced by one having the stiff legs and mast, made of steel angles, latticed. A new duplex deck pump was placed in position. The old and insufficient electric plant and headlights were replaced by a new electric plant, consisting of a 5 K. W. multipolar dynamo direct connected to a Racine automatic engine of sufficient capacity for two 2,000-candlepower search lights and an ample number of incandescent lamps for lighting the boat. After the repairs, etc., were completed, the boat was repainted. During the year the boat ran a total of 5,088 miles, cut and removed from the river and banks 645 trees and snags, towed 258 barges, scows, dredges, and derrick boats a total distance of 2,545 miles. She has been of great service at work at the several dams and locks in towing loaded and empty barges, handling dredges and scows, and assisting in various works of repairs. She has assisted in tearing down and filling lower river crib at Lock No. 1, loaded timber on barges and formed rafts of timber at Frankfort, Ky., and towed same to Locks 1, 2, and 3, for new crib work; loaded 1,301 cubic yards of riprap at Lock No. 2 and 180 cubic yards at Drennon, towed to Lock No. 1, and unloaded same in crib; assisted in backing Dam No. 1 with 1,630 cubic yards of sand, clay, and gravel; repaired upper slope of Dam No. 1; tore out, rebuilt, and filled lower river crib at Lock No. 3; loaded 3,457 cubic yards of stone in barges at quarry at Lock No. 2, towed to Lock No. 3, and unloaded into lower river crib and abutment cribs; tore out upper triangular crib at Lock No. 3; backed Dam No. 3 and Dam No. 5; towed coal to Lock No. 7, and to other points on the river where work was going on; assisted in making survey of Lock No. 8.

U. S. STEAMER COL. G. L. GILLESPIE.

The U. S. steamer *Col. G. L. Gillespie* was put in commission from the 16th to the 28th of May, 1898, for an inspection trip on the improved portion of the Kentucky River, and from the 24th to the 29th of June, 1898, for the purpose of towing the Kentucky River fleet from Frankfort to Lock No. 7 and Lock No. 1. Towed 14 dredges, scows, and barges a total distance of 600 miles. Ran a distance of 720 miles.

U. S. DREDGE NO. 1.

U. S. Dredge No. 1 was in active service at Lock No. 7 until February 16, 1898, when she was taken to Frankfort, Ky., and placed in ordinary. During this time her machinery was overhauled and repaired, new spud placed in position, and the dredge painted. Placed in commission June 27, 1898, towed to Lock No. 1, and dredged lower entrance of lock.

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U. S. DREDGE NO. 2.

The U. S. dredge No. 2 was in active service until March 2, 1898, when she went into ordinary at Frankfort, Ky. She was again put in commission June 24, 1898. She has been employed most of the time in dredging lock entrances and in rebuilding cribs. At Lock No. 1 she dredged 1,805 cubic yards of earth and sand, and removed 15 logs from lock entrance; assisted in tearing out, rebuilding, and filling lower river crib; dredged 385 cubic yards of stone for foundation of crib, and dredged 1,205 cubic yards of clay and gravel for backing dam; assisted in loading and towing timber from Frankfort to Locks 1 and 3; assisted in removing snags in Pool No. 1. At Lock No. 2 she dredged 80 cubic yards from entrances; assisted in filling abutment cribs with 1,498 cubic yards of riprap; in raising and lowering derricks, in loading timbers and riprap onto barges, and in quarry work; tore off old sheeting and range timbers from dam and replaced with new timber; refilled pens of dam with riprap. At Lock No. 3, dredged 85 yards of material from entrances; dredged 70 cubic yards of stone and earth for river crib; assisted in tearing out, rebuilding, and filling lower river crib; tore out upper triangular guide crib; backed dam with 455 cubic yards of clay and gravel. At Lock No. 4, dredged 70 cubic yards of earth and sand from mill race in dam; removed 9 snags from drift pile above highway bridge at Frankfort. At Lock No. 5, dredged 680 cubic yards of gravel and backed dam with same. Made new dipper handle; overhauled and repaired machinery; painted dredge; watched and cared for Government property.

U. S. DERRICK BOAT NO. 1.

The U. S. derrick boat No. 1 was in active service until March 6, 1898, when she was placed in ordinary at Frankfort, Ky. She was towed to Lock No. 7 June 27, 1898. She has assisted in quarry work at Lock No. 2 and in loading riprap on barges for Locks 1, 2, and 3; assisted in repairing abutment crib at Lock No. 3, and in rebuilding lower river crib. Repainted boat and repaired roof; overhauled machinery; watched and cared for Government property.

U. S. DERRICK BOAT NO. 2.

The U. S. derrick boat No. 2 was in active service until March 6, 1898, when she was placed in ordinary at Frankfort, Ky. She was towed to Lock No. 7 June 27, 1898; assisted in tearing out, rebuilding, and filling lower river crib at Locks 1 and 3; assisted in quarry work at Lock No. 2; handled timber and stone for the repairs at the several locks; handled coal for engines; assisted in snagging in Pool No. 1. Repainted boat throughout; overhauled and repaired boat; watched and cared for Government property.

Respectfully submitted.

JOHN M. G. WATT,
Assistant Engineer.

Capt. J. G. WARREN.
Corps of Engineers, U. S. A.

Statement of traffic passing the locks on the Kentucky River during the fiscal year ending June 30, 1898.

Kind of craft.	Number.	Tonnage.
Lock No. 1.		
Passenger boats	817	78,101.21
Towboats	124	12,163.64
Government boats	56	8,229.20
Coal barges	120	30,650.00
Other barges	240	33,250.00
Small craft	85	570.00
Rafts	26	3,143.00
Total	1,468	166,107.05

Total number of lockages, 1,203.

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Statement of traffic passing the locks on the Kentucky River, etc.—Continued.

Kind of craft.	Number.	Tonnage.
Lock No. 2.		
Passenger boats	737	80,064.12
Towboats	129	12,044.98
Government boats	64	8,229.00
Coal barges	130	29,250.00
Other barges	207	31,610.00
Small craft	77	520.00
Rafts	25	2,188.00
Total	1,369	163,906.10

Total number of lockages, 1,260.

Kind of craft.	Number.	Tonnage.
Lock No. 3.		
Passenger boats	346	55,681.37
Towboats	120	10,644.82
Government boats	75	10,518.10
Coal barges	117	26,700.00
Other barges	145	21,330.00
Small craft	70	480.00
Rafts	26	2,660.00
Total	899	130,514.29

Total number of lockages, 845.

Kind of craft.	Number.	Tonnage.
Lock No. 4.		
Passenger boats	295	49,396.54
Towboats	143	13,574.89
Government boats	48	6,128.10
Coal barges	124	28,250.00
Other barges	128	18,550.00
Small craft	118	660.00
Rafts	32	2,660.00
Total	888	119,219.53

Total number of lockages, 847.

Kind of craft.	Number.	Tonnage.
Lock No. 5.		
Passenger boats	227	26,674.12
Towboats	70	8,986.57
Government boats	28	3,928.10
Coal barges	35	8,750.00
Other barges	106	15,900.00
Small craft	149	323.00
Rafts	240	17,829.00
Total	855	82,390.79

Total number of lockages, 726.

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Statement of traffic passing the locks on the Kentucky River, etc.—Continued.

Kind of craft.	Number.	Tonnage.
Lock No. 6.		
Passenger boats	159	21,208.95
Towboats	49	6,569.59
Government boats	30	4,218.10
Coal barges	25	6,250.00
Other barges	80	11,850.00
Small craft	217	1,170.00
Rafts	240	17,845.00
Total	800	69,111.64

Total number of lockages, 567.

Kind of craft.	Number.	Tonnage.
Lock No. 7. [a]		
Passenger boats	58	9,920.39
Towboats	40	5,923.81
Government boats	20	2,854.10
Coal barges	12	3,000.00
Other barges	128	18,900.00
Small craft	111	915.00
Rafts	239	18,348.00
Total	603	59,861.70

[a] Opened for navigation December 11, 1897.

Total number of lockages, 408.

Statement of commerce passing the locks on the Kentucky River from June 30, 1896, to June 30, 1898.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 1.	*Tons.*	*Tons.*	*Tons.*
Coal	22,570	35,460	58,030
Corn	1,411	4,159	5,570
Wheat	902	2,656	3,558
Salt	777	831	1,608
Oil	324	454	778
Whisky	136	254	390
Flour	1,374	1,598	2,972
Sugar	122	168	290
Molasses	68	95	163
Sorghum	48	44	92
Cement	976	674	1,650
Tobacco	5,188	4,238	9,426
Hides	20	18	38
Hay	881	834	1,715
Cattle	160	251	411
Swine and sheep	624	853	1,477
Horses and mules	46	71	117
Lumber	816	1,287	2,103
Timber	11,370	2,316	13,686
Shingles	117	135	252
Manufactured iron	193	149	342
Produce	346	591	937
General and miscellaneous	6,030	9,642	15,672
Total	54,499	66,778	121,277

Passengers, 8,685.

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Statement of commerce passing the locks on the Kentucky River, etc.—Continued.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 2.	*Tons.*	*Tons.*	*Tons.*
Coal	21,428	31,471	52,899
Corn	1,097	3,399	4,496
Wheat	875	2,356	3,231
Salt	748	711	1,459
Oil	322	352	674
Whisky	124	235	359
Flour	763	1,014	1,777
Sugar	98	124	222
Molasses	47	79	126
Sorghum	35	42	77
Cement	791	585	1,376
Tobacco	2,750	2,844	5,594
Hides	15	12	27
Hay	234	320	554
Cattle	80	194	274
Swine and sheep	420	587	1,007
Horses and mules	31	66	97
Lumber	551	1,253	1,804
Timber	11,064	2,389	13,453
Shingles	111	108	219
Manufactured iron	152	218	370
Produce	250	401	651
General and miscellaneous	4,037	9,167	13,204
Total	46,023	57,927	103,950

Passengers, 6,036.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 3.	*Tons.*	*Tons.*	*Tons.*
Coal	17,123	30,412	47,535
Corn	585	3,460	4,045
Wheat	845	2,389	3,234
Salt	700	535	1,235
Oil	242	258	500
Whisky	120	222	342
Flour	537	620	1,157
Sugar	47	75	122
Molasses	23	71	94
Sorghum	21	32	53
Cement	728	619	1,347
Tobacco	1,246	969	2,215
Hides	9	8	17
Hay	140	203	343
Cattle	40	102	142
Swine and sheep	120	280	400
Horses and mules	14	45	59
Lumber	691	1,062	1,753
Timber	8,443	2,165	10,608
Shingles	47	66	113
Manufactured iron	86	238	324
Produce	150	257	407
General and miscellaneous	3,051	4,449	7,500
Total	35,008	48,537	83,545

Passengers, 3,607.

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Statement of commerce passing the locks on the Kentucky River, etc.—Continued.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 4.	*Tons.*	*Tons.*	*Tons.*
Coal	14,107	32,656	46,763
Corn	605	2,863	3,468
Wheat	842	2,362	3,204
Salt	675	423	1,098
Oil	283	199	482
Whisky	102	211	313
Flour	441	495	936
Sugar	43	51	94
Molasses	23	60	83
Sorghum	14	25	39
Cement	789	451	1,240
Tobacco	462	775	1,237
Hides	9	6	15
Hay	104	211	315
Cattle	53	75	128
Swine and sheep	242	65	307
Horses and mules	15	41	56
Lumber	1,120	1,103	2,223
Timber	14,377	2,660	17,037
Shingles	57	87	144
Manufactured iron	76	189	265
Produce	157	127	284
General and miscellaneous	2,651	3,893	6,544
Total	37,247	49,028	86,275

Passengers, 3,239.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No 5.	*Tons.*	*Tons.*	*Tons.*
Coal	710	9,871	10,581
Corn	455	2,874	3,329
Wheat	834	2,167	3,001
Salt	250	120	370
Oil	105	68	173
Whisky	54	198	252
Flour	107	165	272
Sugar	16	10	26
Molasses	11	10	21
Sorghum	4	5	9
Cement	595	82	677
Tobacco	248	93	341
Hides	6	5	11
Hay	131	67	198
Cattle	25	24	49
Swine and sheep	45	25	70
Horses and mules	7	20	27
Lumber	189	96	285
Timber	65,039	18,529	83,568
Shingles	15	8	23
Manufactured iron	28	100	128
Produce	27	32	59
General and miscellaneous	1,447	1,069	2,516
Total	70,343	35,638	105,981

Passengers, 2,870.

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Statement of commerce passing the locks on the Kentucky River, etc.—Continued.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 6.	*Tons.*	*Tons.*	*Tons.*
Coal	701	3,724	4,425
Corn	166	2,872	3,038
Wheat	810	1,708	2,518
Salt	201	100	301
Oil	161	43	204
Whisky	67	186	253
Flour	95	150	245
Sugar	10	10	20
Molasses	7	6	13
Sorghum	4	2	6
Cement	469	80	549
Tobacco	189	41	230
Hides	5	4	9
Hay	108	136	244
Cattle	11	7	18
Swine and sheep	21	5	26
Horses and mules	4	22	26
Lumber	125	45	170
Timber	65,283	17,645	82,928
Shingles	8	7	15
Manufactured iron	18	185	203
Produce	6	11	17
General and miscellaneous	1,353	1,686	3,039
Total	69,822	28,675	98,497

Passengers, 2,880.

Articles.	Fiscal year 1897.	Fiscal year 1898.	Total for two years.
Lock No. 7.	*Tons.*	*Tons.*	*Tons.*
Coal	.....	3,712	3,712
Corn	.....	2,879	2,879
Wheat	.....	13	13
Salt	.....	33	33
Oil	.....	18	18
Whisky	.....	137	137
Flour	.....	19	19
Sugar	.....	3	3
Molasses	.....	3	3
Sorghum	.....	1	1
Cement	.....	28	28
Tobacco	.....	3	3
Hides	.....	1	1
Hay	.....	16	16
Cattle	.....	6	6
Swine and sheep	.....	1	1
Horses and mules	.....	11	11
Lumber	.....	69	69
Timber	.....	18,294	18,294
Shingles	.....	3	3
Manufactured iron	.....	19	19
Produce	.....	24	24
General and miscellaneous	.....	421	421
Total	.....	25,714	25,714

NOTE.—Lock No. 7 opened for navigation December 11, 1897.

Passengers, 983.

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List of boats plying on the Kentucky River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Gen. O. M. Poe	U. S. Towboat	145.6	34	4.6	150
Col. G. L. Gillespie	do	110	25	3	82
Burnsides	Packet	136	21	4.6	92.11
Falls City	do	132.5	27	4.4	223.35
Dick Brown	do	132	24	4.5	148.99
George W. Moredock	do	126.5	25.4	3.2	148.75
John Barrett	do	124.8	31	5.5	187.23
Mary Stewart	do	100	30.4	3.2	91.92
Annette	do	93	21	3.6	92.11
Jim Montgomery	do	92.6	17	2.9	31.80
F. J. O'Connell	do	92.6	18.1	2.4	57.62
Mary F. Golden	do	86.2	16.2	3.6	37.14
Eureka	do	56	13.8	2.5	45.60
Old Elk	do	51	10	3	4
Gunther	do	30	7	3.5	4.50
Mary Lacy	Towboat	127	28	4	155.03
Jim T. Duffy, jr	do	120	26	3.8	232.55
Pavonia	do	120	26	4	132.60
Al Martin	do	112	22.6	4	96.88
Troubadour	do	94.4	18	3	61.37
Andy	do	85	11	7	43.40
Willington	do	66.5	15.2	2.8	45.45
Charley Boy No. 2	do	58	10.5	2.6	44.96
Saratoga	do	23	6	2	8.70
Ghent	do	53	10	4	4.85
Louise	Tugboat	60.4	9.5	2	9.43
Owl	do	56.3	10.2	2.6	8.08
City of Warsaw	do	41	14	3	4.50
E. W. Groves	do	40	10	3	4.39
Tom Ross	do	33	7.8	3.6	9.72
T. C. Woodard	do	30	9	5	3.80
Bob Lee	do	23	6	2.6	4.50
Champion No. 2	Sawmill boat	128	21.8	3.5	126
D. D. Baker	do	117	18.3	4.3	70.33
Sawyer	do	93.4	19.2	2.9	39.93
Dixie	Pleasure boat	45	8.6	4	3.72
Ann T	do	32	7	4	3
Emily	do	25	6	2.6	1.50
Richland	do	21	6	2.5	4.50
Cliff B	do	21	6	2	4.50

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APPENDIX FF.

IMPROVEMENT OF OHIO RIVER, AND OF MUSKINGUM RIVER, OHIO, OF NEW RIVER, VIRGINIA AND WEST VIRGINIA, AND OF CERTAIN RIVERS IN WEST VIRGINIA AND EASTERN KENTUCKY.

REPORT OF MAJ. W. H. BIXBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating snag boat on Ohio River.
3. Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.
4. Movable Dams Nos. 2, 3, 4, 5, and 6, Ohio River.
5. Muskingum River, Ohio.
6. Operating and care of locks and dams on Muskingum River, Ohio.
7. Little Kanawha River, West Virginia.
8. Operating and care of lock and dam on Little Kanawha River, West Virginia.
9. Great Kanawha River, West Virginia.
10. Operating and care of locks and dams on Great Kanawha River, West Virginia.
11. Elk River, West Virginia.
12. Gauley River, West Virginia.
13. New River, Virginia and West Virginia.
14. Guyandotte River, West Virginia.
15. Big Sandy River, West Virginia and Kentucky.
16. Operating and care of lock and dam on Big Sandy River, West Virginia and Kentucky.
17. Tug Fork of Big Sandy River, West Virginia and Kentucky.
18. Louisa [Levisa] Fork of Big Sandy River, Kentucky.

SURVEYS.

19. Ohio River, from Marietta, Ohio, to Pittsburg, Pa., preliminary report.
20. Big Sandy River, including Tug and Louisa forks, West Virginia and Kentucky, for locks and dams.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 20, 1898.

GENERAL: I have the honor to transmit herewith the annual reports of the works under my charge for the fiscal year ending June 30, 1898.

I took charge of these works October 6, 1897, relieving Maj. W. H. Heuer, Corps of Engineers.

Second Lieut. Wm. B. Ladue, Corps of Engineers, was under my immediate orders until April 11, 1898, he having been on duty in this district since August 13, 1897.

Very respectfully, your obedient servant,

W. H. BIXBY,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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IMPROVEMENT OF OHIO RIVER.

In the Annual Report of the Chief of Engineers for 1896, Part IV, pp. 2062–2063, is a general statement of the condition of the river, drainage area, population, commerce, etc., and the methods applied to the improvement.

Much of the information contained in the tables below relating to the commerce of the Ohio River has been furnished by Mr. C. B. Murray, superintendent of the Cincinnati Chamber of Commerce. Some data was also supplied by Mr. J. Frank Tilley, assistant secretary of the Pittsburg Coal Exchange.

Davis Island bank protection, 4.75 miles below Pittsburg.—The Chief of Engineers having approved a recommendation that the washout of land complained of by the owner, Thomas Deily, be remedied by a protection of piling and riprap, at an estimated cost of $1,300, circulars were issued and award made for the work, which was completed in November.

Material expended: Stone, 342 cubic yards; timber, linear feet, 7,569.

Dam between Davis and Neville islands, 4.75 miles below Pittsburg.—This dike is of the ordinary type on the Ohio River, being a crib work filled with riprap and paved 12 inches deep with stone. The paving is frequently broken by ice and drift, and when a break occurs a whole bin or square is washed out. In this way nearly all the paving of this dike has been renewed. During September three squares were repaired, two with stone and one with hard brick set on end and laid in cement. It is believed this will give much more satisfactory results.

Raccoon Bar, 28.5 miles below Pittsburg.—A model barge of railroad iron having sunk on this bar in July, 1897, the cargo was removed and the barge subsequently abandoned by its owners. The wreck, which was immediately below the cofferdam of Dam No. 6, was entirely removed, but while on the bar had caused an increase of several feet in its height, forming a serious obstruction and making navigation difficult on less than 7 feet of water, especially if the cofferdam should remain in place during the winter. Ten-day circulars for the necessary dredging were issued and the work awarded at 16½ cents per cubic yard. Dredging was carried on from the last of October until the middle of November, making a cut about 250 feet wide and 800 feet long, extending to deep water below, relieving all difficulty from insufficient water.

Total excavation, 16,150 cubic yards.

Survey of Ohio River, Marietta to Pittsburg.—The field work of this survey was in progress at the first of the year, and, with the exception of precise levels, which occupied a few days longer, was entirely completed on September 29. Conditions for field work were favorable and excellent progress was made, the survey party covering about 120 miles of river between July 1 and October 4. Since the close of the field work the completion of the maps was in progress up to the end of the year and these are now nearly completed in pencil.

The entire survey has been directed with great efficiency and thoroughness by Mr. R. R. Jones, assistant engineer, whose report is herewith.

Marietta Island, 167¾ miles below Pittsburg.—Repair of protection dike at head of island. With a view of stopping further undermining at the upstream end of dike, all cavities in the rubblestone substruc-

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ture were filled with concrete, the broken end of dike was then reshaped with concrete and finished so as to present a smooth surface to the action of the water. About 15 cubic yards of concrete was used; cement expended, 12 barrels.

Blennerhassett Island, 184 miles below Pittsburg.—The protection of the bank at the head of the island, by building two short spur dikes and placing a revetment of brush and stone, under ten-day circulars, and award to J. T. Hart, of Marietta, Ohio, was begun July 26 and completed August 14. The revetment extends 820 feet; at its lower end a short additional dike was built of surplus stone.

Material expended:

Stone	cubic yards..	1,912
Brush	cords..	403
Earth filling	cubic yards..	445

Rising Sun Bar, 502 miles below Pittsburg.—En route to Cullums the United States dredges stopped here to remove a gravel lump in the channel, which high water compelled them to leave in 1893, and also to build a spur at the root of the dike. Ensuing high water preventing work above, they continued operations here until December 2, when placed in winter quarters.

Excavation, cubic yards, 18,220.

Craigs Bar, 537.5 miles below Pittsburg.—Work here by the Government dredges Ohio and Oswego was a resumption of their operations in 1896 on the cemented gravel bar on the Kentucky side of the river. Operations were begun July 10 and completed September 25, giving a channel 4,400 feet long, with a minimum width of 220 feet and a center depth of 5 feet. Navigation at this point had previously been more difficult than at any other point between Cincinnati and Louisville. The new channel affords safe and easy passage of ample width.

Excavation: Cubic yards, 82,304; snags removed, number, 104; weight, tons, 39.3.

The two loose stone dikes at this place, built under agreement with Richardson and Hall, of Newport, Ky., which were left unfinished in 1896, were completed by the addition of 542 cubic yards stone to level up and build dike heads.

Total stone expended, cubic yards, 7,769.8.

Madison Harbor, Ind., 552.5 miles below Pittsburg.—As the low water prevented dredging at other points, the Ohio and Oswego were brought here, where the conditions were more favorable, and were employed from October 1 to November 9 in widening the channel by dredging off the gravel bar opposite the dike. The channel was widened 260 feet, making it 380 feet in width at the narrowest point. The extreme length of area dredged is 2,810 feet to a depth of 5 feet below low water. There is now a safe channel for tows as well as packets.

Flint Island, 683 miles below Pittsburg.—The work projected was the formation of a channel through the bar near the left side of the river, and is in continuation of that done during the two previous seasons. Dredging was begun July 14 by the plant hired under contract of W. A. Kirk and continued until December 10, the cuts made aggregating about 7,550 feet in length and 25 feet in width, principally to a depth of 6 feet.

Material excavated, cubic yards	67,190
Snags removed, number	29

The work was under the efficient and thorough supervision of Mr. J. Nelson Caldwell, assistant engineer, whose report is herewith.

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French Island, 761 miles below Pittsburg.—Two loose stone dikes started and nearly completed in 1896 by Bedford, Weikel & Nugent, of Evansville, Ind., under ten-day circulars, were finally completed in September by building up the unfinished portion to required height and width.

Evansville, Ind., 783 miles below Pittsburg. (See Annual Report of Chief of Engineers, 1897, p. 2328.)—Work under contract with Eichel & Arnold and Eigenmann & Hollerbach, which was stopped in June by high water, was resumed on the dikes in July and completed about September 15, 1897. At that time the dikes were causing a decided scouring of the channel.

Total material expended:

Piles	number..	736
Brush	cords..	1,082
Stone	cubic yards..	13,849

Before beginning work on the bank protection it appeared, from further examination of the caving banks, that better results could be secured by a change in the method; and a modification of the contract and supplemental articles of agreement for this purpose were authorized by the Secretary of War July 22, 1897, and signed July 31. Work commenced the last of September and continued until December 10, when suspended for the season. The prevalence of extreme low water throughout the summer and very high water throughout the winter prevented much progress, and owing to the latter cause operations could not be resumed until the latter part of June, 1898.

The protection now extends about 2,988 feet and gives every indication of effectively preventing further scour so far as the protection extends.

Total material expended to date:

Piles	number..	499
Slabs	cubic yards..	7,952
Stone	do....	7,587.3
Embankment	do....	24,127

Mount Vernon, Ind., 819 miles below Pittsburg.—In December, 1897, a sunken wharf boat, and in June, 1898, a crane-boat wreck, both reported as dangerous obstructions, were removed by the mate of the U. S. snag boat *E. A. Woodruff* and part of her crew.

Details are given in the report on snag boat operations.

Shawneetown, Ill., 848 miles below Pittsburg.—Mr. Charles Carroll, a prominent citizen of this place, having reported damage to the embankment built to protect the town from floods, which was thought to endanger its safety, an examination was ordered, from which it appeared that about 2,000 cubic yards would be necessary to place it in good condition.

A recommendation to expend the available funds, about $1,300, was approved by the Chief of Engineers July 9, 1897. Bids were invited by circular letter, and under award to F. F. Harrison, at 22 cents per cubic yard for earth in place, work was begun September 1 and completed October 12, and was regarded by the officials of the town as very satisfactory.

Golconda, Ill., 890.5 miles below Pittsburg.—The work proposed at this place was under a project approved June 30, 1897, for obtaining a channel 6 feet deep and as wide as the funds ($3,000) would permit between the Illinois shore and a large gravel bar directly in front of the town. Work was begun July 27 and continued until September 10, at which time the new channel was 1,500 feet long, 7 feet deep, 100 feet wide for

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a distance of 850 feet, and 70 feet wide for the remaining 650 feet. This work afforded marked relief, but additional dredging is necessary at the rock bar above, where the rock should be removed and the new channel widened.

Material excavated, cubic yards, 16,930.

This work, as also the dredging at Brooklyn, Ill., and Paducah, Ky., was under the efficient supervision of Mr. William A. Christian, assistant engineer, whose report is herewith.

Paducah, Ky., 920 miles below Pittsburg.—At the urgent request of steamboat-men and others interested in navigation the Brown dredging plant was transferred to this place on October 5 and remained until October 14, clearing the channel of numerous sand reefs, the dredged area aggregating 1,000 feet in length and 70 feet in width to a depth of 6 feet.

Material excavated, cubic yards, 4,040.

During the progress of this work an old city water-works crib, filled with stone and strongly bolted together, located near the channel at the foot of Tennessee River Island, was removed with dynamite.

Brooklyn, Ill., 923.5 miles below Pittsburg.—On completion of work in Golconda Harbor the Brown dredging plant was brought to this place for similar work, the project, approved July 27, 1897, being to give easy access to the steamboat landing at low stages by the removal of logs and obstructions and by blasting and dredging a ledge of rock to about 5 feet below low water, so far as the funds ($10,000) would permit.

Operations were begun September 12, 1897, and closed January 13, 1898. Besides going over the entire area dredged in 1889, removing rocky lumps that hindered navigation, the bar at the lower end of the wharf was dredged over an area of 750 by 150 feet to a depth of 6 feet at low water, and a number of logs, etc., removed.

Material excavated, cubic yards, 19,695.

Operating United States dredges.—The plant consists of 2 dredges, 4 dump scows, and 1 flatboat, with a towboat as tender, hired for each working season, fuel for operating the dredges being included in the contract price. As the dredging season usually begins before the close of the fiscal year, the report necessarily comprises operations during part of two distinct seasons.

The steamer *Bob Ballard*, which served as tender for the dredges for the season of 1897, was furnished under contract with Richardson & Kraft, dated April 10, 1897, at $30 per day and $2 per day additional when at work below Louisville, Ky.

On July 1, 1897, the dredges had finished work at Guyandotte Bar and were en route to Craigs Bar, 537.5 miles below Pittsburg, where they remained until September 25, when work was completed. Serious interruptions occurred from high water in July and September. It was the intention to next employ the fleet at Cullums Bar Ripple or Guyandotte Bar, both urgently requiring attention, but as the low stage of river would not permit their employment at either place they were taken to Madison, Ind., where good results could be accomplished. They remained here till November 9, when a higher stage enabled them to start to Cullums. On the way they stopped to finish some work formerly begun at Rising Sun, and the river soon afterwards became too high for the work contemplated above. Operations for the season were entirely suspended on December 2, and the fleet was ordered to winter quarters in the mouth of the Kentucky River. On

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May 23, 1898, they arrived at Cincinnati, to make necessary repairs before going into commission, and at the close of the year these are nearly completed.

The record of work at Craigs, Madison, and Rising Sun is given under those headings.

The operations of the Government dredging fleet are conducted with great efficiency and thoroughness by Mr. E. J. Carpenter, assistant engineer, whose report, herewith, gives a statement of the work done in detail.

Hired dredging plants.—In addition to the work done by the Government dredges, which are kept fully employed during the season, a large amount of excavation has been necessary on the lower river, to carry out the improvements designed for maintaining navigation at low stages. For this purpose two plants, each consisting of 1 dredge, 1 towboat, and 3 dump scows, were hired under contract in 1896 and 1897. The plants hired in 1896 were furnished by William A. Kirk, of Madison, Ind., and H. S. Brown, of Quincy, Ill., under contracts approved August 6 and 15, 1896, respectively. The same parties were the lowest bidders in 1897; contracts approved April 14 and 16, respectively. High water prevented work until July, after which it was carried on through the season. The work done is stated in the reports on Flint Island, Paducah, Ky., and the harbors of Golconda and Brooklyn, Ill.

Ice piers.—An ice harbor at Syracuse, Ohio, and one at or near the mouth of the Big Hocking River, were directed by the river and harbor act of June 3, 1896. Projects were submitted February 18, 1897, for building ice piers by contract at both localities, at an estimated cost of $7,000 for each harbor. By indorsement of March 12, 1897—E. D. 19741—the Secretary of War directed that "this matter be held for the present." Balance available for the work, $10,515.58.

Harbor lines.—Work on these lines at Pittsburg, Wheeling, and Cincinnati was carried on throughout the year whenever practicable, both in the field and office, in establishing permanent monuments and other reference points and completing the map data of same. In the field special attention has been given to the numerous illegal encroachments beyond lines previously fixed by the various Boards of Engineers. In each case the owner of the property concerned has been notified of the penalties affixed by law. As an indication of the extent to which such filling has been heretofore carried, it may be stated that during the year 16 cases have been reported in the vicinity of Pittsburg, 33 at and near Wheeling, and 5 at Cincinnati.

Under date of February 19, 1898, the Chief of Engineers authorized a careful local survey for establishing harbor lines on the Ohio River at Ironton, Ohio, at a cost of $1,000 to $1,500. Work was begun June 1, 1898, and is now in progress under the efficient supervision of Mr. A. B. McGrew, whose report on harbor-line work is herewith.

Removal of obstructions.—The low stage of water during the month of October, 1897, which prevented work by the United States snag boat, served to locate a number of obstructions previously complained of, and exposed to view many rocks and snags not apparent at higher stages. In order to take advantage of the favorable condition for their removal, proposals were asked by poster and circular letter for the hire of a light-draught steamboat and a derrick boat properly equipped for the service, and manned by a part of the snag boat crew. Award was made at $15 per day for the steamboat and $8 per day for the derrick boat. Work was begun at Cincinnati October 20, working down river to Lawrenceburg, Ind., 24½ miles below, and thence to Pomeroy, 218

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miles above, returning thence to Cincinnati, when work was suspended on November 20 by cold weather. During this time the outfit removed:

Snags	number..	118
Sunken rock	cubic yards..	60

During January, 1898, some recently sunken boats near Pittsburg, Pa., were reported as serious obstructions, and, having been abandoned by the owners, were removed by the hire of steamboats properly equipped for the service. These wrecks consisted of 1 coal boat near the Point Bridge, Pittsburg, of a part of the steamer *Percy Kelsey* and two barges at Merrimans Bar, 9 miles below, and 1 coal boat at Hays Bar, 10 miles below.

During March, 1898, 6 coal boats, 4 barges, and 1 flat were removed in the same manner, all being abandoned wrecks, and all, except one at Bellaire, Ohio, being located in the channel near Pittsburg.

A quantity of piling and stone placed around the piers during the reconstruction of the Pennsylvania Railroad bridge between Cincinnati, Ohio, and Newport, Ky., remained for a considerable period as obstructions to navigation, but was all finally removed by the railroad company, under the supervision of this office, in November, 1897.

PERMITS.

During the year this office has had supervision of the placing of various structures in the river, under permits issued by the Secretary of War, as follows:

Bellevue, Pa.—Water main at a depth of 4 feet below river bed, by Riverview Water Company. Completed May, 1898. Permit for an additional main under same conditions was issued in May, 1898.

Dixmont, Pa.—Timber-crib filter in bed of river, by Western Pennsylvania Hospital, Department for the Insane.

Rochester, Pa.—Filtering crib on Lacocks Bar and a 10-inch suction pipe under river bed, by Rochester Tumbler Company.

Wheeling, W. Va.—Extension of water works pumping station 13 feet beyond established harbor line, by city of Wheeling.

Bellaire, Ohio.—To fill solid and construct trestle outside of established harbor line, by Pennsylvania Railroad Company.

Cincinnati, Ohio.—Intake pier to be connected by a tunnel with pumping station, by commissioners of Cincinnati Waterworks.

Bridges.—The plans for a bridge over the Ohio between Benwood, W. Va., and Bellaire, Ohio, reported upon April 23, 1897, were subsequently amended, making a slight change in the location and providing for a channel span of 850 feet, and were thus approved by the Secretary of War May 26, 1898.

Plans for a bridge between Marietta, Ohio, and Williamstown, W. Va., were considered by a Board of Engineers and approved by the Secretary of War February 4, 1898.

UNCOMPLETED PROJECTS.

The following is a statement of several works of improvement, principally by dredging, which have been projected and plans approved, but which urgent work elsewhere or other causes have thus far prevented of accomplishment.

Cullums Bar, 471½ miles below Pittsburg.—Owing to the hard nature of the river bed, the dikes built at this place in 1891 failed to induce the expected scour; and, as the channel was very narrow and close to

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the Kentucky shore, a project was submitted May 23, 1896, approved May 27, 1896—E. D. 15384—to widen the channel by gradual dredging as opportunity offered and experience indicated, at an approximate cost of $10,000 to $20,000, and, if necessary, to extend the dike at a cost of $1,000. This work, partly completed, will be resumed when the stage of water permits and the dredges can be spared from other more important work.

Gunpowder Bar, 509 miles below Pittsburg.—The project submitted February 25, approved February 27, 1895, for 2 dikes, stated that some dredging would probably be necessary. The dikes have not produced the desired scour, and dredging to 5 feet below low water should be carried about 3,800 feet, with a width of 200 feet. Work was begun in November, 1895, but stopped by high water. This work will be resumed and completed when permitted by the stage of water and availibility of dredges.

Mound City, Ill., 959 miles below Pittsburg.—Project submitted May 11, 1897, for expenditure of $10,583.97 in removing by dredging, and drilling and blasting if found necessary, as much material as can be handled, with a view of obtaining a least channel depth of 6 feet below low water, for about 6,000 feet and 300 feet in width. Approved May 21, 1897, E. D. 21072. Funds for the work at Mound City were provided in the river and harbor acts of 1892 and 1896, and may be used, when necessary, for the purpose indicated. This work will be taken up as soon as the stage of water is suitable therefor.

There also remains, and may be used when necessary, an unexpended balance of $4,009.10 from $13,000 appropriated by the river and harbor act of July 13, 1892, for completing the embankment on the south side of the Great Miami River near its junction with the Ohio, to confine the waters of the Miami in great floods, and to arrest the formation of the bar obstructing navigation in the Ohio. This work will be resumed when its necessity becomes apparent.

STAGES OF THE OHIO RIVER DURING 1897.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Upper, Middle, and Lower Ohio:

Gauge of Davis Island Dam, near Pittsburg, Pa.

[When the dam is up low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	15	8.5	4
February	0	28	22	26.6	4.4
March	0	31	31	17.4	7.2
April	0	30	30	13.2	5.8
May	0	31	21	14.1	4.1
June	1	29	0	5.7	2.7
July	5	26	12	9.4	2.6
August	2	29	4	6.8	2.9
September	29	1	0	3	1.5
October	31	0	0	2.1	1.2
November	10	20	7	11.3	1.4
December	0	31	26	13.7	5.5
Total	78	287	168	.....	.....

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Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	17.8	9.3
February	0	28	28	61.1	10.1
March	0	31	31	55.6	30.2
April	0	30	30	36.2	15.1
May	0	31	31	35	12
June	0	30	30	20.7	9
July	0	31	31	24.8	9.1
August	0	31	31	18	7.5
September	0	30	5	7.1	3.2
October	0	31	0	4.2	3.1
November	0	30	21	13.6	3.2
December	0	31	31	25.5	12
Total	0	365	300	.....	.....

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	16	7
February	0	28	28	42.7	8.3
March	0	31	31	43.6	32.3
April	0	30	30	33.5	15.4
May	0	31	31	26.4	10.7
June	0	30	29	14.4	5.9
July	0	31	31	17.4	6.4
August	0	31	21	17	5
September	17	13	1	6.1	1
October	31	0	0	1	.4
November	11	19	9	9.3	.6
December	0	31	31	19	7.9
Total	59	306	273	.....	.....

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River. The general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati Suspension Bridge shall have a draw for use in high water, unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge at Louisville is exceptionally located, and no record of its operation is kept. Reports received from the Cincinnati Southern Railroad Bridge at Cincinnati and the Kentucky and Indiana Bridge at Louisville state that the draw of the former was not opened for the passage of boats during the calendar year ending December 31, 1897, and that the latter was opened five times during that period.

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STOPPAGE OF NAVIGATION.

The usual period of extreme low water prevailed from the middle of September until the middle of November, when navigation was only possible for steamboats of the smallest draft.

There was no suspension of navigation on account of ice.

The following table shows the reported losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River to the end of the calendar year 1897:

Losses by collision with bridges.

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
East Liverpool Bridge:				
February 9, 1897	W. H. Brown's Son	Jim Brown	1 barge coal	$1,500.00
Bellaire Bridge:				
Previously reported				137,656.00
January 8, 1897	T. M. Jenkins & Co	Resolute	3 barges coal	3,500.00
Total				141,156.00
Newport and Cincinnati Railroad Bridge:				
Previously reported				44,107.00
December 2, 1896	C. Jutte & Co	Resolute	3 barges coal	4,000.00
Total				48,107.00
Cincinnati Southern Railroad Bridge:				
Previously reported				9,812.00
February 23, 1897	Lysle Coal Co	B. D. Wood	3 barges coal and 4 barges damaged.	5,000.00
Total				14,812.00
Cairo Bridge:				
Previously reported				25,119.95
February 16, 1897	John A. Wood & Son	John A. Wood	1 boat coal	2,000.00
February 20, 1897	W. H. Brown's Son	Sam Brown	1 flat coal	1,100.00
Total				28,219.95

Losses by collision with Ohio River bridges to December 31, 1897.

Beaver Bridge	$56,340.00
East Liverpool Bridge	1,500.00
Steubenville Bridge	97,608.00
Wheeling and Martins Ferry Bridge	9,800.00
Bellaire Bridge	141,156.00
Parkersburg Bridge	77,777.00
Point Pleasant Bridge	9,600.00
Kenova Bridge	24,400.00
Newport and Cincinnati Railroad Bridge	48,107.00
Covington and Cincinnati Railroad Bridge	93,300.00
Cincinnati Southern Railroad Bridge	14,812.00
Louisville and Jeffersonville Bridge	7,800.00
Ohio Falls Bridge	80,350.00
Kentucky and Indiana Bridge	27,767.00
Henderson Bridge	20,520.00
Cairo Bridge	28,219.95
Total	739,056.95

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ESTIMATES.

In work of the character of that for the improvement of the Ohio River it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and therefore it is impossible to submit estimates for complete improvement. The work must be progressive and tentative, and, owing to the varied interests and communities along nearly 1,000 miles of river, the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand and improvement completed in advance of other parts of the river unless large amounts of money are provided. The great and growing commerce of this river, its numerous cities, and the rapid increase of the already large population of the valley should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods. The sum of $1,000,000 can be profitably used and produce immediate results in great improvement for the movement of the vast commerce of the river. Attention is particularly invited to the commercial statistics appended.

Money statement.

July 1, 1897, balance unexpended		$296,409.72
Amount appropriated by sundry civil act approved July 1, 1898		*15,000.00
		311,409.72
June 30, 1898, amount expended during fiscal year		115,896.41
July 1, 1898, balance unexpended		195,513.31
July 1, 1898, outstanding liabilities	$12,266.41	
July 1, 1898, amount covered by uncompleted contracts	6,953.15	
		19,219.56
July 1, 1898, balance available		176,293.75
Amount that can be profitably expended in fiscal year ending June 30, 1900. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		1,000,000.00

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriation.	Allotment.	Remarks.
March 3, 1827	$30,000.00		
March 3, 1835	50,000.00		
July 2, 1836	20,000.00		
March 3, 1837	60,000.00		
July 7, 1838	50,000.00		
June 11, 1844	100,000.00		
March 3, 1847	6,479.25		
August 30, 1852	90,000.00		
June 23, 1866		$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do		80,000.00	Snag boats and apparatus for improving Western rivers.
March 2, 1867	100,000.00		

* Shawneetown, Ill.

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Statement of amounts and dates of all appropriations for this work—Continued.

Act of Congress.	Appropriation.	Allotment.	Remarks.
July 25, 1868		$85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	$50,000.00		
March 3, 1871	50,000.00		
June 10, 1872	200,000.00		
March 3, 1873	200,000.00		
June 23, 1874	150,000.00		
March 3, 1875	300,000.00		
August 14, 1876	175,000.00		
June 18, 1878	300,000.00		
Do	50,000.00		Harbor of refuge at or near Cincinnati.
March 3, 1879	250,000.00		
June 14, 1880	250,000.00		
March 3, 1881	350,000.00		
March 21, 1882	100,000.00		Continuing work on Davis Island Dam.
August 2, 1882	350,000.00		
Do	16,000.00		Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00		
Do	17,000.00		Do.
August 5, 1886	375,000.00		
August 11, 1888	380,000.00		
September 19, 1890	300,000.00		
January 19, 1891	2,128.87		Relief of Stubbs & Lackey. Treasury settlement No. 2593.
July 13, 1892	360,000.00		
August 18, 1894	250,000.00		
June 3, 1896	250,000.00		
July 1, 1898		15,000.00	For restoring levee and banks of Ohio River at or near Shawneetown, Ill.
Total	5,831,608.12	352,000.00	

Total of appropriations, 1827–1898	$5,831,608.12	
Total of allotments, 1827–1898	352,000.00	
Received from sales, 1866–1893	7,790.50	
		$6,191,398.62
Appropriations not drawn, 1827, 1852	5,023.47	
Allotments not drawn, 1866, 1868	43,134.60	
Returned by Treasury settlements	30.07	
Amounts transferred to other works	125,168.44	
		173,356.58
Total		6,018,042.04

List of contracts in force during the fiscal year ending June 30, 1898.

Constructing dikes in Ohio River at and near Evansville, Ind.: Eichel & Arnold and Eigenmann & Hollerbach; January 2, 1897; approved January 9, 1897; be prepared to commence April 1, 1897; terminate December 1, 1897; completed September, 1897.

Constructing protection work on Ohio River near Evansville, Ind.: Eichel & Arnold and Eigenmann & Hollerbach; January 2, 1897; approved January 9, 1897; be prepared to commence April 1, 1897; terminate December 1, 1897; supplemental contract modifying method of work signed July 31, 1897; approved August 17, 1897; extended to October 1, 1898.

Hire of towboat and crew as tender to United States dredges: Richardson & Kraft; March 30, 1897; approved April 10, 1897; commence when ordered; terminate about December 1, 1897.

Hire of dredging plant: Wm. A. Kirk; April 7, 1897; approved April 14, 1897; commence when directed; terminate when discharged.

Hire of dredging plant: H. S. Brown; April 10, 1897; approved April 16, 1897; commence when directed; terminate when discharged.

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STAGES OF THE OHIO RIVER.

Highest, lowest, and average stages of the Ohio River at Cincinnati each calendar year from 1860 to 1897, inclusive, with the highest stage during the floods of 1832 and 1847.

Calendar year.	Highest stage.			Lowest stage.			Average for the year.	
	Date.	Stage.		Date.	Stage.			
		Ft.	In.		Ft.	In.	Ft.	In.
1832	Feb. 18	64	3					
1847	Dec. 17	63	7					
1860	Apr. 16	49	2	Oct. 3	5	4	16	0
1861	Apr. 19	49	5	July 13	5	1	19	1
1862	Jan. 24	57	4	Oct. 31	2	4	17	5
1863	Mar. 12	42	9	Oct. 6	2	6	15	0
1864	Dec. 23	45	1	Aug. 6	3	1	16	8
1865	Mar. 7	56	3	Oct. 19	5	8	21	10
1866	Sept. 26	42	6	Aug. 17	4	9	19	2
1867	Mar. 14	55	8	Oct. 19	3	0	17	0
1868	Mar. 30	48	3	July 21	5	1	18	8
1869	Apr. 2	48	9	Aug. 21	5	4	19	8
1870	Jan. 19	55	3	Oct. 4	3	10	17	10
1871	May 13	40	6	Oct. 12	2	8	11	10
1872	Apr. 13	41	9	Oct. 14	3	0	11	8
1873	Dec. 18	44	5	Oct. 12	3	8	18	5
1874	Jan. 11	47	11	Sept. 22	2	4	15	8
1875	Aug. 6	55	4	Sept. 19	4	3	18	9
1876	Jan. 29	51	9	Sept. 4	6	2	18	2
1877	Jan. 20	58	9	Oct. 9	3	3	15	0
1878	Dec. 15	41	4	Oct. 24	4	4	16	9
1879	Dec. 27	42	9	Oct. 23	2	6	14	6
1880	Feb. 17	53	2	Oct. 28	3	9	17	0
1881	Feb. 16	50	7	Sept. 18	1	11	16	11
1882	Feb. 21	58	7	Nov. 1	6	1	a22	1½
1883	Feb. 15	b66	4	Sept. 21	3	7	a19	5½
1884	Feb. 14	c71	0½	...do	2	9	a17	4
1885	Jan. 20	46	0	Sept. 26	2	6	a15	7
1886	Apr. 9	55	9	Nov. 1	3	4	a17	10
1887	Feb. 5	56	3	Sept. 23	2	8	a15	1½
1888	Apr. 1	39	11	Aug. 7	5	3	a17	11
1889	Feb. 22	38	3	Sept. 13	5	3	a18	6
1890	Mar. 26	59	2	Aug. 30	5	9	a25	8
1891	Feb. 25	57	4	Oct. 7	4	5	a20	6
1892	Apr. 25	43	8	Nov. 5	3	5	a16	6
1893	Feb. 20	54	11	Aug. 30	3	7	a17	8
1894	Feb. 15	35	6	Sept. 14	3	1	a12	9
1895	Jan. 14	48	4	Oct. 28	2	3	a12	2
1896	Apr. 4	47	8.4	Sept. 25	5	6	a17	1.2
1897	Feb. 26	61	2	Oct. 18	3	1	a16	5

a Prepared from the stages as shown by the waterworks marks daily at 6 a. m. and 6 p. m., the previous years having been made from one daily observation at 6 a. m.
b Four o'clock to 5 o'clock a. m., inclusive.
c Twelve o'clock noon to 1.30 p. m.

MONTHLY COMPARISONS OF RIVER AND RAINFALL.

Highest, lowest, and average monthly stages of the Ohio River and the monthly and annual rainfall at Cincinnati in two years ending December 31, 1896 and 1897.

Months.	Highest.				Lowest.				Average.		Rainfall.	
	1897.		1896.		1897.		1896.		1897.	1896.	1897.	1896.
	Date.	Feet.	Date.	Feet.	Date.	Feet.	Date.	Feet.	Feet.	Feet.	Inches.	Inches.
January	25	17.9	1	24.8	3	9.8	21	7.6	14.3	14.1	2.48	1.49
February	26	61.2	9	33.10	1	9.11	29	12.4	36.7	23.6	5.27	1.56
March	1	55.6	31	36.11	31	28.4	1	12.5	40.2	22.8	9.89	3.20
April	15	36.8	4	47.8	30	15.1	25	15.6	26.3	25.11	3.08	0.59
May	17	35	9	17.9	31	11.9	26	7.10	23.2	12.2	2.46	2.17
June	24	20.9	30	26.8	10	11.1	3	8.10	8.10	11.10	1.87	2.70
July	28	24.10	29	46.9	3	14.1	9	9.10	9.1	22.2	6.71	7.40
August	1	18	2	41.9	31	7.3	31	9.8	10.2	19.10	1.91	3.70
September	1	7.2	30	9.9	28	3.3	25	5.5	4.8	6.8	0.64	5
October	20	4.4	6	25.5	18	3.1	16	9.9	3.6	14.9	0.46	2.29
November	23	13.7	30	21.5	6	3.3	8	9.8	8	13.8	6.80	3.29
December	22	25.6	2	29.11	1	12	31	10.2	17.9	16.7	2.32	1.09
For the year.	*a* 26	61.2	*b* 4	47.8	*c* 18	3.1	*d* 25	5.5	16.5	16.6	43.89	34.48

a February. *b* April. *c* October. *d* September.

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Commerce of Ohio River in 1897.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Coal shipments from Pittsburg.	Pittsburg to Cairo	965	8	2,067,369	
Huntington and St. Louis Towboat Co.	do	965	6	80,656	
Gray's Iron Line	do	965	10	17,391	
Steamer H. K. Bedford	Pittsburg to Louisville	598	11	13,800	7,650
McKinley Coal Co	do	598	8	95,415	
Steamer Adelle	do	598	8.5	2,000,000	
Relief Towboat Co	do	598	12	155,000	
Steamer Virginia	Pittsburg to Cincinnati	467	7.6	19,200	8,288
Steamer Keystone State	do	467	9	35,190	8,640
Steamer Hudson	do	467	7	31,787	2,300
Steamer Queen City	do	467	8	2,700	3,173
Steamer Argand	do	467	11	8,865	16,545
Steamer Eliza	Pittsburg to Gallipolis	267	9	23,000	1,400
Steamer Catherine Davis	Pittsburg to Point Pleasant	263.5	9	53,620	17,180
Steamer Kanawha	do	263.5	10.5	20,500	12,000
Steamer Ben Hur	Pittsburg to Parkersburg	183	9	11,247	9,324
Steamer D. T. Watson	do	183	3.5	1,766,612	
Steamer Lorena	do	183	8.5	10,000	4,000
Steamer Bob Ballard	do	183	7	5,595	
Steamer Lexington	Wheeling to Matamoras	51	9	3,000	12,500
Steamer Ruth	Wheeling to Sistersville	46	9	36,500	28,800
Steamer Leroy	Wheeling to Clarington	28	9.5	52,000	11,774
Steamer T. N. Barnsdall	Sistersville to Marietta	35	9	13,000	16,000
Steamer G. W. Moredock	Marietta to Louisville	427	7.5	64,000	
Steamer Columbia	Marietta to Point Pleasant	92.5	8	9,621	2,965
Steamer Valley Belle	Marietta to Middleport	78.5	8.5	12,600	5,130
Steamer Crown Hill	Parkersburg to Cincinnati	284	10	90,000	
Steamer Rob Roy	Parkersburg to Long Bottom	24	6	50,000	9,000
Steamer M. P. Wells	Ravenswood to Cincinnati	246.5	10	10,000	20,000
Steamer Klondike	Ravenswood to Middleport	31	2	20	2,000
Steamer Little Queen	Millwood to Middleport	20	10	918	6,993
Steamer New Haven	New Haven to Louisville	355.5	12	24,636	
Steamer Mary L. Hatcher	Syracuse to Gallipolis	24	10	4,712	6,700
John Barrett & Son	Pomeroy to Cairo	717	11	71,500	
Steamer Gate City	do	717	8	84,850	
Big Sandy Towboat Co	Pomeroy to Louisville	350	9	165,000	
Steamer Lee H. Brooks	Pomeroy to Madison	305	4	6,830	6,977
Cincinnati, Portsmouth, Big Sandy, and Pomeroy Packet Co.	Pomeroy to Cincinnati	219	10	122,901	32,071
Steamer Lyda	do	219	1	7,000	
Steamer Jessie	do	219	6	14,400	
Steamer Coal Bluff	Point Pleasant to Cairo	701.5	6	66,000	
Kanawha and Ohio Transportation Co.	Point Pleasant to Carrollton	277.5	3	180,500	
A. Montgomery & Co	Point Pleasant to Cincinnati	203	7	71,800	
Victor Towboat and Dock Co.	do	203	6	31,238	
The Marmet Co	do	203	8	160,000	
Steamer Claribell	Point Pleasant to Gallipolis	4	9	5,126	5,836
Steamer Carrie Brown	Gallipolis to Huntington	39	10	4,765	12,870
Steamer Enos Taylor	do	39	7.3	1,596	11,400
Steamer J. H. McConnell	Guyandotte to Louisville	295	6	50,000	
Steamer Chevalier	Huntington to Portsmouth	47	10	9,000	10,000
Steamer Lucy Coles	do	47	12	10,853	
Steamer F. J. O'Connell	Catlettsburg to Cairo	651	9	175,000	
Steamer Favorite	Catlettsburg to Ironton	11	0.5	20	
Zuhars Bros	Hanging Rock to Louisville	270.5	5	7,656	
Steamer Silver Wave	Portsmouth to Cincinnati	113.5	7	7,000	12,000
Buena Vista Freestone Co	Buena Vista to Cincinnati	95.5	10	5,000	
John A. Borches	Manchester to Warsaw	130	10	13,530	
Steamer Henrietta	Maysville to Louisville	193	6		760
The Coney Island Co	Maysville to Aurora	88	3	525	412,542
James Tucker	Maysville to Lawrenceburg	84	11	6,500	
Steamer Tacoma	Chilo to Cincinnati	35	10	6,500	16,873
Steamer John Mackey	New Richmond to Carrollton	95	10	644,300	
Steamer Alice L. Barr	New Richmond to Aurora	47	12	800,000	
James R. Ware & Co	New Richmond to Riverside	26	6.6	17,700	
Smith Coal and Sand Co	Dayton to Addyston	17	11	53,250	
Henry Spillie & Son	Dayton to Cincinnati	3	8	3,000	
R. H. Flemming	Newport to Ludlow	3	1	3,041	
Steamer Little Albert	Cincinnati to Cairo	499	9	4,492	
Memphis and Cincinnati Packet Co.	do	499	10	77,583	8,892
Louisville and Cincinnati Packet Co.	Cincinnati to Louisville	132	11	129,032	115,507
Steamer Levi J. Workum	Cincinnati to Vevay	66	12	11,315	6,558
Steamer Mary F. Golden	Cincinnati Harbor				11,165

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Commerce of Ohio River in 1897—Continued.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Steamer Swan	Aurora to Rising Sun	10	12	320	1,440
Steamer Falls City	Carrollton to Louisville	57	8	4,544	4,608
Steamer Jim Montgomery	Madison to Cannelton	164	9	4,500	765
Louisville and Jeffersonville Ferry Co (excursion).	Madison to Leavenworth	105	12		854,062
Steamer John L. Lowery	Madison to Westport	21	10	3,080	7,526
Bergenroth Brothers	Louisville to Cairo	367	12	1,010,000	
Steamer S. D. Blair	do	367	12	20,000	
Louisville and Evansville Mail Co.	Louisville to Henderson	197	9	76,334	21,790
Steamer Raymond	Louisville to Derby	88.5	12	5,402	115
Steamer Jack Osborn	Cannelton to Evansville	66	12	15,300	
Steamer G. B. Monteith	do	66	6	20,600	
Steamer Gertrude	Owensboro to Caseyville	111	12	9,920	25,730
Steamer R. L. Reel	Mouth Green River to Evansville.	8	7	90	2,730
Steamer Kalista	do	8	a 20	5	270
Steamer I. N. Hook	do	8	8	27,000	
Steamer J. C. Kerr	do	8	12	10,450	6,750
Steamer Gayoso	do	8	12	9,900	5,937
Steamer Peter Honts	Evansville to Cairo	182	10	16,000	1,200
Steamer W. K. Phillips	Evansville to Smithland	128	8	6,400	3,200
Steamer John F. Buckham	Evansville to Metropolis	146	10	6,673	8
Steamer D. A. Nisbet	Evansville to Paducah	137	10	11,850	10,408
Steamer Herbert Moran	do	137	12	1,881	56
Steamer Racket	do	137	8	5,234	
Steamer Joe Fowler	do	137	12	11,535	11,998
Nashville and Evansville River Packet Co.	do	137	9	10,400	3,080
Steamer John S. Hopkins	do	137	10.5	9,500	4,450
Steamer Jewel	Evansville to Henderson	12	12	3,500	3,800
Steamer Maggie Belle	Saline River to Cairo	108.5	.5	600	
Steamer Emma Cooper	Saline River to Paducah	63.5	7	90,000	
Steamer Dick Clyde	Caseyville to Brooklyn	63	7	13,176	
Steamer Dick Fowler	Paducah to Cairo	45	12	4,500	25,450
St. Louis and Tennessee River Packet Co.	do	45	10	28,600	12,514
Geo. H. Cowling	Paducah to Metropolis	9	12	3,087	27,263
Steamer Penguin	Paducah and vicinity				
Steamer H. W. Buttorff	Paducah to Smithland	9	9	7,500	3,800
Total				11,265,638	1,914,763

a Days.

River commerce of Cincinnati for the year ending December 31, 1897.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Alcohol		15	15	Fish	102	504	609
Ale, beer, and porter	2	2,015	2,017	Flour	874	2,255	3,126
Apples, green	1,904	644	2,548	Fruit, green	436		437
Bagging	19	15	34	Fruit, dried	150	107	256
Barley	5	6	11	Furniture		656	659
Beans	88	246	334	Glass, window	220	89	306
Beef		6	6	Glassware	2,184	2,122	4,301
Boots and shoes	91	364	455	Grease	231	80	311
Bran, middlings, etc	165	214	379	Hardware	792	1,769	2,566
Brooms		28	28	Hay	2,886	170	3,058
Broom corn	1	1	2	Hides	403	65	462
Butter	190	21	211	Hog products	18	2,514	2,534
Candles		74	74	Hogs	9,680	14	9,693
Castings	2,125	522	2,647	Hops	11	22	35
Cattle	2,503	112	2,615	Horses	672	643	1,314
Cement and plaster	908	1,038	1,946	Iron and steel	10,637	4,697	15,338
Cheese	4	59	63	Iron and steel, scrap	228		226
Cider	208	171	379	Iron, pig	45	121	162
Coffee	15	835	850	Lead, white		682	686
Cooperage	929	1,417	2,346	Leather	462	156	618
Corn	732	134	866	Lemons	2	108	110
Corn meal	2	123	125	Lime	325	354	679
Cotton	8,006	312	8,318	Lumber	5,070	4,290	9,360
Crockery	115	417	532	Malt		103	103
Eggs	736	95	831	Manufactures, sundry		658	658
Feathers	85	4	89	Merchandise	17,339	21,516	38,855

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River commerce of Cincinnati for the year ending December 31, 1897—Continued.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Molasses	4,486	1,649	6,135	Soap	29	442	471
Nails	10,774	5,232	16,006	Sorghum	223	38	261
Oats	62	196	258	Spices	11	16	27
Oil	602	747	1,349	Starch		1,063	1,063
Onions	136	154	290	Sugar	1,336	2,458	3,794
Oranges	1	200	201	Tallow	230	5	235
Peanuts	44	256	300	Tobacco, leaf	16,295	2,101	18,396
Petroleum	350	1,363	1,713	Tobacco, manufactured	40	260	300
Potatoes	2,020	776	2,796	Turpentine	14	21	35
Rice	109	75	184	Vegetables, green	353	711	1,064
Rope, twine, etc	4,984	3,940	8,924	Vinegar		1,252	1,252
Rosin	1,029	175	1,204	Wheat	1,720	1,083	2,803
Rye	721	110	831	Whisky	4,797	3,297	8,094
Salt	10,703	7,442	18,145	Wines and liquors	230	393	623
Seed, clover and timothy	178	1,185	1,363	Wool	116	117	233
Sheep	604	39	643	Yarn, cotton	433		433
Shot	3	93	96				

RECAPITULATION.

	Tons.
Receipts	129,233
Shipments	89,472
Total	218,705

Coal shipments from Pittsburg, Pa.

[Furnished by Capt. William Evans.]

Month.	To Cincinnati.				To Louisville.			
	Trips.	Coal boats.	Coal barges.	Tons.	Trips.	Coal boats.	Coal barges.	Tons.
1897.								
January	4		54	26,512				
February	27	105	245	201,713	34	170	132	230,521
March	24	85	160	171,689	18	97	76	137,726
April	26	80	160	160,200	20	97	90	154,487
May	30	40	250	205,475	30	50	150	243,150
July	10		50	228				
November	17	54	250	169,637	18	23	217	94,287
December	24	41	340	137,726	20	25	180	134,014
Total	162	405	1,509	1,073,180	140	462	845	994,187
Grand total								2,067,367

NOTE.—No shipments in June, August, September, or October.

Comparative table showing coal shipments from Pittsburg during the eleven years ending December 31, 1897.

Year.	To Cincinnati.	To Louisville.	Total.	Year.	To Cincinnati.	To Louisville.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1887	788,690	1,367,012	2,155,702	1893	829,878	1,534,523	2,364,401
1888	1,950,882	2,223,494	4,174,376	1894	1,153,765	1,300,022	2,453,787
1889	1,149,892	1,439,747	2,589,639	1895	1,036,661	1,357,212	2,393,873
1890	1,324,641	2,095,716	3,420,357	1896	1,809,785	2,292,405	4,102,190
1891	1,065,705	1,828,047	2,893,752	1897	1,073,180	994,187	2,067,367
1892	914,430	1,384,864	2,299,294				

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Commerce passing Davis Island Dam, Ohio River, for the calendar year 1897.

Vessels.	Ascending.				Descending.				Total freight.
	Lock.		Pass.		Lock.		Pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	58	4,812	219	28,693	56	4,213	219	29,516	67,234
Towboats	105	0	1,002	0	87	0	1,046	0	0
Model barges	8	0	44	2,800	0	0	45	26,500	29,300
Coal boats	34	0	387	0	0	0	1,021	918,932	918,932
Barges	102	119	2,823	15,600	2	0	3,058	1,596,000	1,611,715
Flats	186	2,625	1,091	11,856	170	6,372	1,330	197,652	218,505
Rafts	0	0	1	100	3	1,200	32	117,023	118,323
Miscellaneous	45	0	138	0	81	0	160	0	0
Total	533	7,552	5,705	59,049	399	11,785	6,911	2,885,623	2,964,009

Commerce passing Dam No. 6 in 1897.

Vessels.	Ascending.	Descending.	Total.	Vessels.	Ascending.	Descending.	Total.
	Number.	*Number.*			*Number.*	*Number.*	
Packets	273	266	539	Flats	730	905	1,635
Towboats	887	883	1,770	Rafts		6	6
Model barges	53	76	129	Miscellaneous	19	15	34
Coal boats	378	834	1,212				
Barges	2,643	3,126	5,769	Total	4,983	6,111	11,094

The tonnage is almost identical with that of Davis Island Dam, Ohio River.

Comparative statement of commerce passing the Falls of the Ohio River by canal and by river.

Year.	Canal.		Open river.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1882	3,988	985,628	2,305	668,866	6 293	1,604,494
1883	5,231	1,349,115	1,484	483,281	6,715	1,832,396
1884	3,485	785,192	1,548	484,124	5,033	1,269,316
1885	5,678	1,443,181	822	262,862	6,500	1,706,043
1886	4,964	1,240,112	1,796	577,547	6,760	1,817,659
1887	4,069	867,807	2,297	1,204,518	6,366	2,072,325
1888	6,963	1,915,365	2,252	1,162,305	9,215	3,077,670
1889	5,534	1,404,573	1,984	957,829	7,518	2,362,402
1890	4,386	998,062	3,828	1,717,158	8,214	2,715,220
1891	4,739	1,302,471	2,137	1,062,428	6,876	2,364,899
1892	5,506	1,275,329	1,826	858,953	7,332	2,134,282
1893	3,902	848,211	1,722	514,317	5,624	1,362,528
1894	5,280	1,245,899	461	149,937	5,741	1,395,836
1895	3,921	859,491	945	316,269	4,866	1,175,760
1896	6,046	1,542,347	1,426	436,955	7,472	1,979,302
1897	3,932	933,056	1,965	583,600	5,897	1,516,656

Number of steamers in the freight and passenger traffic between Cincinnati and other ports, and total tonnage, compared for ten years.

Year.	Number.	Tonnage.	Year.	Number.	Tonnage.
Fiscal year.			*Calendar year.*		
1887–88	48	24,348	1893	36	22,569
1888–89	42	24,453	1894	34	20,527
1889–90	48	23,583	1895	30	18,587
1890–91	37	24,145	1896	25	15,032
1891–92	40	23,374	1897	27	15,881

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List of Ohio River steamers destroyed in the year 1897, causes of destruction, and tonnage represented.

Name.	How destroyed.	Tonnage.
City of Vevay	Dismantled	339.54
Sherley	Sunk	430.96
Telegraph	...do	983.42
Total tonnage destroyed		1,753.92

Annual arrivals and departures of steamers at Cincinnati for years indicated.

Year.	Arrivals.	Departures.	Year.	Arrivals.	Departures.
Fiscal year.			*Fiscal year*—Continued.		
1872–73	2,340	2,333	1887–88	2,113	2,115
1873–74	2,596	2,600	1888–89	2,521	2,522
1874–75	2,602	2,665	1889–90	2,257	2,252
1875–76	2,779	2,808	1890–91	2,234	2,234
1876–77	2,646	2,653	1891–92	2,185	2,188
1877–78	2,942	2,942	*Calendar year.*		
1878–79	2,725	2,730			
1879–80	3,163	3,167	1892	2,052	2,062
1880–81	2,638	2,633	1893	1,891	1,894
1881–82	2,739	2,736	1894	1,687	1,694
1882–83	2,340	2,329	1895	1,028	983
1883–84	2,170	2,162	1896	1,124	1,042
1884–85	2,137	2,138	1897	950	948
1885–86	2,489	2,483			
1886–87	2,272	2,281			

Arrivals and departures of steamboats at the port of Cincinnati, Ohio.

Year.	Arrivals.				Departures.			
	From New Orleans.	From Pittsburg, Pa.	From other ports.	Total.	For New Orleans.	For Pittsburg.	For other ports.	Total.
Fiscal year.								
1887–88	35	156	1,389	1,580	37	153	1,385	1,575
1888–89	51	237	2,233	2,521	51	237	2,234	2,522
1889–90	38	197	2,022	2,257	37	194	2,021	2,252
1890–91	31	208	1,995	2,234	31	207	1,996	2,234
1891–92	23	204	1,958	2,185	23	202	1,963	2,188
Calendar year.								
1892	20	186	1,846	2,052	22	185	1,854	2,062
1893	17	120	1,754	1,891	17	120	1,757	1,894
1894	26	100	1,561	1,687	25	102	1,567	1,694
1895	24	*a* 52	952	1,028	26	*a* 46	911	983
1896	21	*a* 106	997	1,124	24	*a* 111	967	1,042
1897	32	*a* 91	827	950	27	*a* 94	827	948

a Includes Wheeling, W. Va.

Schedule of rates on flour per barrel by rail and river from Cincinnati for eleven years ending December 31, 1897.

Year.	To Pittsburg.		To Louisville.		To New Orleans.		To Memphis.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1887	24–31	15	15	15	44–49	35	.....	.....
1888	22–24	15	15	15	40–49	35	.....	.....
1889	23	15	15	15	54	35	.....	.....
1890	23–24	15	15	15	49–54	35	.....	.....
1891	24	15	15	15	49	35	.....	.....
1892	24	15	15	15	49	35	40	30
1893	24	15–20	15	15–10	49	35–30	40	30–40
1894	24	20	15	10	49	40	40	30
1895	20–24	20	15	10	49	40	40	30
1896	20–22	20	15	10	49	40	40	30
1897	10–24	20	*a* 15	10	*a* 49	40	*a* 40	30

a Per 100 pounds.

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REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON SURVEY OF OHIO RIVER, MARIETTA TO PITTSBURG.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, June 30, 1898.

MAJOR: I have the honor to submit herewith a report of operations on the survey of the Ohio River from Marietta to Pittsburg for the fiscal year ending June 30, 1898.

This work, which had been suspended November 30, 1896, was resumed in June, 1897.

The field work was carried on from the beginning of the fiscal year to October 4.

The field work was completed to Marietta, with the exception of precise levels, on September 29, and the greater part of the force was then disbanded. On completion of the precise levels, October 4, the remainder of the force was disbanded, the quarter boat laid up in the Muskingum River, and the *Edna* sent down to Cincinnati with the maps and instruments.

The work of completing the maps has been in progress since the field work was ended, and the maps are now nearly completed in pencil.

The weather and general conditions of the river were favorable during the season of 1897, and the survey made excellent progress, covering about 120 miles of river between July 1 and October 4.

The best day's work of the various divisions of the survey was as follows: Main transit line, 4¼ miles in ten hours; precise levels, 2¼ miles in six hours; soundings, 4 miles in eleven hours; topography and cross-section levels, 3½ miles in ten hours. The precise levels were run twice over the same course, and the other divisions of the survey once only.

The main transit line was begun in September, 1896, at the center of the Point Bridge, Pittsburg, at the south end. At Davis Island the transit line was "tied in" with the Pittsburg Harbor survey. The transit line terminated at a point along the shore front of Williamstown, W. Va., about 1,600 feet below the mouth of the Muskingum River, at Marietta, and 171 miles 4,800 feet below the Point Bridge, Pittsburg, September 29, 1897. During the season of 1897 the line was largely carried along the exposed beach, thereby saving much of the heavy clearing rendered necessary during the seasons when the beach is covered by water. As the transit party could frequently outstrip the others, it turned back to run auxiliary base lines and take topography on the right bank. The precise-level work was restricted to the time between 9 a. m. and 3 p. m., on account of the more variable temperature prevailing before and after the hours named. As the levels were checked back over the course originally run, the actual distance traveled over was twice the apparent run.

The topography work involving the largest day's work was the determination of the cross sections of banks on 23 lines; the location of railroads, highways, and adjacent towns or detached buildings, islands, dikes, etc.

The work performed by sounding party on a day's run of 4 miles involved the taking of soundings on 52 lines crossing the river, and a total of 1,253 soundings, located by transit from stations on base line.

The main transit (base) line and the precise levels were run along the left bank from Pittsburg to Marietta. Where islands were encountered auxiliary base lines were run along the right bank and connected with the main base line.

Metallic monuments were buried beneath the ground surface 1 mile apart, near the even mile points, and the elevation of these bench marks was determined with reference to mean sea level at Sandy Hook, N. J. In addition, bench marks were established on many public buildings at towns and on the masonry of bridges crossing streams tributary to the Ohio.

The allowable error in precise level work was one one-hundreth of a foot per mile. The allowable error in cross-section levels was two one-hundredths of a foot per mile. The soundings were taken at intervals of about 40 feet, on lines 400 feet apart.

When the precise levels reached Marietta they were connected with a line run by the United States Engineers from the Coast and Geodetic Survey bench mark at Parkersburg, W. Va. This completed a circuit connecting Sandy Hook, N. J., Easton, Harrisburg, and Pittsburg, Pa., the Ohio River from Pittsburg, Pa., to Parkersburg, W. Va., and via Parkersburg, W. Va., Cumberland, Md., Harrisburg, Pa., to Sandy Hook, N. J. The final closure of the circuit, at bench mark on the coping of the ice-harbor lock at Marietta, Ohio, gave the following results:

	Feet.
Precise levels, via Ohio River from Pittsburg, Pa., above sea level.....	591.78
Precise levels, via Ohio River from Parkersburg, W. Va., above sea level...	591.88
Difference	0.10

that is, the disagreement of the level lines, on their final closure, was one-tenth of 1 foot in a distance of more than 1,500 miles.

During the season of 1897 the assistants in charge of the various divisions of the survey were as follows: Main transit line, A. F. Spreen, assisted by M. C. Oppen-

heimer; precise levels, A. B. McGrew; soundings, C. B. Harris; topography, E. W. Buell and C. E. Mehlhope; cross-section levels, G. A. Loeb and H. E. Frye; draftsman on quarter boat, W. D. Janney; receiver of material, George L. Hazelton. These gentlemen showed great energy and capacity in the prosecution of the work.

In the platting of the maps, since the completion of the field work, I have been assisted by Mr. J. Nelson Caldwell, assistant engineer, and Mr. E. W. Buell, assistant surveyor.

The maps are platted to a scale of 200 feet to 1 inch and cover a total length of 385 feet.

The profiles showing low-water surface and bed of river are drawn to a horizontal scale of 5,000 feet to 1 inch and a vertical scale of 4 feet to 1 inch.

The soundings and topography are now nearly finished in pencil, and a considerable part of the sounding work is entirely finished.

Respectfully submitted.

R. R. JONES, *Assistant Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. EDMUND MOESER, ASSISTANT ENGINEER, ON PROTECTION AT HEAD OF MARIETTA AND BLENNERHASSETT ISLANDS.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, June 30, 1898.

MAJOR: I have the honor to submit the following report of work on the Ohio River assigned to this office during the fiscal year ending June 30, 1898:

Protection dam at head of Marietta Island, 168 miles below Pittsburg.—This dam was built in 1894 to stop the erosion at head of island, caused by the action of the water pooled by the back-channel dam. An examination made July, 1897, showed that undermining and partial collapse of about 10 feet had occurred at the upstream end of the concrete dam. Otherwise there was no sign of abrasion on the face or disintegration in the concrete over its length of 225 feet. To prevent further damage, the stone in the substructure was replaced, 15 cubic yards of concrete filled over end of dam and the surface reshaped, at a total cost of $39.66.

Protection work at head of Blennerhassett Island, 184 miles below Pittsburg.—The project for this work, approved June 16, 1897, was for brush and stone revetment of bank, supplemented by two short loose stone spur dikes, at an estimated cost of $2,400. Bids for the work were opened July 6, 1897, and contract awarded to Josiah T. Hart, of Marietta, Ohio, July 10, 1897. Active operations were commenced July 26 and work was completed August 14, 1897.

The bank over the distance revetted, 820 feet, was refilled and graded where necessary; layers of brush were laid over the bank, extending from below the low-water surface to about 15 feet above this surface, and a covering of stone, about 15 inches deep, filled over the brush. Two stone spur dikes were constructed within the limits of the revetment laid, to prevent further washing of the bank.

The following is a statement of the material expended and cost of the work:

Stone (1,912 cubic yards)	$1,606.08
Brush (403 cords)	201.50
Earth filling (445 cubic yards)	178.00
Incidentals, inspection and traveling expenses	87.05
	2,072.63

Respectfully sumitted.

EDMUND MOESER, *Assistant Engineer.*

Maj. W. H BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. J. NELSON CALDWELL, ASSISTANT ENGINEER, ON DREDGING AT FLINT ISLAND.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 15, 1898.

MAJOR: I have the honor to submit the following report of operations at Flint Island, Ohio River, 683 miles below Pittsburg, Pa., during the season of 1897:

The work at this place consisted in dredging to prodnce a channel through the bar near the left side of the river and was done by a dredging fleet composed of a dredge,

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three dump scows, and a tender, furnished by William A. Kirk, of Madison, Ind., under contract dated April 7, 1897. The dredging fleet was ordered to Flint Island July 4, and arrived there July 6. The river was too high to begin dredging and active operations were not started until July 14. One cut and part of another, the first being the nearer to the Kentucky shore, had been made at this place during the season of 1896, and my instructions were to complete the cut left unfinished and make one additional cut. The dredging during 1896 had been to a depth of 5 feet below low water. I was instructed to dig to 6 feet below low water.

Upon examination by carefully made soundings, I found that the cuts made in 1896 had filled up, so that instead of 5 feet at low water, there was, except near the upper end, not more than from 2 to 4 feet at that stage.

I placed the dredge as nearly as practicable at the place where work had been stopped in 1896, completed the cut, and then set the dredge back to a point where soundings indicated 6 feet at low water, and proceeded to make a third cut. Work proceeded very well until a point nearly opposite Dike No. 4 had been reached, when, owing to the low stage of water and strong cross currents, it was found necessary to cease removing material with scows and put the dredge to work clearing out the material carried by the cross currents into the cuts previously made. The material removed by the dredge was deposited on the bar to the right, on the line of the third cut, and when sufficient depth and width had been cleared for the tender to operate, this material, as well as the original bar, was removed to the required depth with scows.

After the third cut was completed it was found that the cross currents had again carried material into the second cut and partially filled it. It was therefore decided to redredge the first and second cuts and the dredge was removed to the upper end of the work.

It was found that there had been a deposit of drift, gravel, and sand between the deep water and the area indicated to be dredged. The dredge was therefore moved further up where sounding showed 6 feet at low water, in line with the second cut, and a cut made to connect with the second cut.

At this time the river began rising, and instead of continuing throughout the second cut the dredge was moved down to a point on this cut where redredging was most needed and the work continued through the remainder of the cut. The river had reached such a stage that it was found impossible, with the dredge in use, to dig deeper than 5 feet at low water.

By the time the dredge had reached the lower end of the cut the river was too high for it to operate, and after remaining inactive for a week to ascertain if the river would fall sufficiently for further work, a proper stage not being reached and there being no probability that such stage would be again reached during the season, on December 10, 1897, the work was closed.

The material removed consisted of 67,190 cubic yards of gravel, sand, blue clay, and drift, and 29 snags. The total expenditure at Flint Island for the season of 1897 was $9,420.25. Of this amount I have charged $9,131.65 to removing gravel, etc., and $288.60 to removing snags. The cost per cubic yard for removing gravel, etc., was therefore about 13⅝ cents.

I submit herewith a blue print* upon which I have indicated the method by which the work was located and shown in full red lines the area dredged in 1897 and in dotted red lines the area dredged in 1896.

The 1897 water line at 1.5′ above low water along the main shore and Sun Fish Bar is shown by dotted black lines.

The highest part of Sun Fish Bar is nearly opposite the high part of the lower end of Flint Island, and was just uncovered at 5.6′ above low water.

Respectfully submitted.

J. NELSON CALDWELL, *Assistant Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM A. CHRISTIAN, ASSISTANT ENGINEER, DREDGING AT GOLCONDA AND BROOKLYN, ILL., AND PADUCAH, KY.

CINCINNATI, OHIO, *June 15, 1898.*

MAJOR: I have the honor to submit the following report of dredging operations on the Ohio River at Golconda, Ill., Paducah, Ky., and Brooklyn, Ill., during the season of 1897:

Golconda, Ill., 890.5 miles below Pittsburg, Pa.—By the river and harbor act of 1896 the sum of $3,000 was appropriated for improving the harbor at Golconda, Ill.

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*Omitted.

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On July 25, 1897, I was instructed to proceed from Cincinnati, Ohio, to Golconda, Ill., to improve the harbor of the latter place by dredging it to a depth of 6 feet at low water. Low water being assumed as zero on the gauge at Paducah, Ky.

The object of dredging at Golconda, Ill., was to open the channel between the Illinois shore and a large gravel bar directly in front of the town.

On April 10, 1897, a contract was awarded to Mr. H. S. Brown, Quincy, Ill., for a dredging plant consisting of 1 dredge, 3 scows, and 1 steamboat, to be used as a tender. This fleet arrived at Golconda, Ill., July 26, 1897.

I arrived at Golconda, Ill., on July 25, 1897, and as there was no recent survey of the river at this point it was necessary to make one to obtain the true conditions of the harbor. I therefore made and platted a survey during the morning of July 27, 1897, and at noon put the dredging plant to work at a point about 300 feet below the mouth of Lusk Creek. The dredging plant continued operations until the evening of July 30, 1897, when work was suspended on account of a sudden rise in the river.

On August 6, 1897, the river having fallen sufficiently, work was again resumed, and continued until September 10, 1897, when it became necessary to stop dredging at this particular place on account of lack of funds.

The new channel made by the dredge is about 1,500 feet long and 7 feet deep at low water, with a width of 100 feet from the head of the cut to a distance downstream of about 850 feet. The remaining 650 feet was cut to a width of only 70 feet when the work was stopped. The material removed consisted chiefly of sand, gravel, loose rocks, and snags. The snags varied in length from 10 to 64 feet, and from 8 to 36 inches in diameter.

All material removed was deposited, in the form of a dike, on the channel side at the foot of Golconda Island. These deposits deflected the water and caused it to flow through the newly dug channel.

The dredging performed at Golconda, Ill., greatly benefited navigation, as it afforded steamboats easier access to the town during low water; but much additional dredging is necessary to make the improvement complete, as an existing rock bar above the newly cut channel ought to be removed and the channel be given a width of not less than 150 feet.

The rock bar referred to is an abrupt projection from the shore just above the mouth of Lusk Creek, at the upper edge of the town, and it makes navigation dangerous and difficult to steamboats that have to land at Golconda in low water, and the risks are much increased to those having to land there at night.

Paducah, Ky., 921 miles below Pittsburg, Pa.—In compliance with orders received on October 4, 1897, the dredging fleet moved from Brooklyn, Ill., to Paducah, Ky., and commenced cutting a channel through the sand reefs, which were then obstructing the crossing between Paducah, Ky., and Owens Landing, Ill.

The dredging at Paducah, Ky., was done during an extremely low stage of river, which necessitated light loading of scows and caused much loss of time by their unavoidable grounding. These delays necessarily reduced the rate of excavation.

The dredge was set to work on the reefs near the Illinois shore, and cut a channel 400 feet long, 70 feet wide, and 6 feet deep at low water. The dredge was then moved, and cut a channel 650 feet long, 70 feet wide, and 6 feet deep at low water between the dry sand bar and Tennessee River Island. The material removed consisted of light sand. While the dredge was thus employed I removed by exploding dynamite an old city waterworks crib situated near the channel at the foot of Tennessee River Island, which had long been abandoned by the city of Paducah. This crib was 50 feet long, 30 feet wide, and said to be 12 feet deep. It projected about 4 feet above water at the time of its removal. It was constructed of 8 inch by 10 inch white oak timbers, all firmly held together at every intersection by iron bolts 1 inch square. The interior of the crib was packed with broken stone and sand. All was removed level with the sand bar, but it would have been reduced to a lower level if the dredge could have been gotten up to it.

Brooklyn, Ill., 925.5 miles below Pittsburg, Pa.—The project for improving the harbor at Brooklyn, Ill., provides for continuing the removal of rocks and cemented gravel from the wharf in front of the town by dredging to a least depth of 6 feet at low water with one of the dredging fleets engaged under contract, assisted by drilling and blasting when necessary.

The dredging was designed to improve the harbor, as provided for in the river and harbor act of 1896, which appropriated $10,000 for the work.

In 1884 the Brooklyn Rock, which was a formation of ferruginous cemented stone, covered an area of about 150 feet by 650 feet, lying directly in front of Brooklyn, Ill., was broken by dynamite blasting and removed by the Ohio River dredges. In 1889 a neck of the same formation, extending from the shore to the lower end of the rock bed, was dredged off by contract with H. S. Brown, Quincy, Ill. In 1892 the landing was further improved by dredging off the bar below the railroad incline. The work done in 1897 was to extend the improvement commenced in 1884 and worked at again in 1889 and 1892.

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The dredging plant used this year was furnished by H. S. Brown, Quincy, Ill., under contract dated April 10, 1897, and was the dredging plant recently employed at Golconda, Ill.

The bar at the lower end of the wharf was formed on strata of ferruginous cemented gravel, found at a depth of from 3 to 4 feet below the loose-gravel river bed. This was so hard that it was difficult for the dredge to remove it, even after being blasted, as the intended effects of the blasting were defeated in many places by reason of the gravel forming a cushion that protected the rock strata. Almost the entire area dredged in 1889 was gone over again in order to remove many rocky lumps that were a hindrance to navigation.

The shore bar at the lower end of the wharf was dredged over an area of 150 feet by 750 feet to a depth of 6 feet at low water. This improvement will permit boats to land at the wharf during the lowest navigable stages of the river.

The material removed at this place consisted of ferruginous cemented and loose gravel, clay, logs, tie poles, cross-ties, etc., all of which were deposited on the Kentucky shore, directly in front of Brooklyn, Ill.

This work was begun on September 12, 1897, and continued until interrupted by high water December 24, 1897. On December 30, 1897, the river had again fallen sufficiently to permit a resumption of operations. From this date work was continued until January 13, 1898, when another rise stopped the work, and there being no prospects for resuming work again during the present season the dredging fleet was discharged January 18, 1898.

STATEMENT OF OPERATIONS AT GOLCONDA, ILL.

Time at work.	Days.	Time lost.	Days.
Dredge	33	Dredge (inactive)	7
Tender	33	Tender (inactive)	7
		Sundays	6

Excavation, July 27 to September 10, 1897.

Sand, gravel, loose rocks	cubic yards..	16,930
Snags	number..	58

Cost of work.

Dredging	$2,635.00
Salaries	240.00
Sundry expenditures	62.15
Total	2,937.15

Cost per unit.

Per cubic yard of excavation	$0.1734

OPERATIONS AT PADUCAH, KY.

Dredge at work	days..	9

Excavation, October 5 to October 14, 1897.

Sand	cubic yards..	4,040

Cost of work.

Dredging	$575.00
Salaries	50.00
Sundry expenses	5.00
Total	630.00

Cost per unit.

Per cubic yard of excavation	$0.105

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OPERATIONS AT BROOKLYN, ILL.

Time at work.	Days.	Time lost.	Days.
Dredge	88.9	Dredge (inactive)	9.9
Tender	90.4	Tender (inactive)	8.4
		Sundays	19
		Accidents	4.4
		Holidays	1

Excavation, September 12, 1897, to January 18, 1898.

Cemented and loose gravel, etc	cubic yards	19,695
Logs	number	17
Large rocks	do	10
Cross-ties	do	76

Cost of work.

Dredging	$6,713.00
Salaries	640.00
Sundry expenses	259.20
Total	7,612.20

Cost per unit.

Per cubic yard of excavation	$0.3875

Respectfully submitted.

WILLIAM A. CHRISTIAN, *Assistant Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER, ON WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1897.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, March 17, 1898.

MAJOR: I have the honor to submit herewith report of operations of Ohio River dredges for the calendar year 1897, with tabular statement showing cost, amount of excavation, etc.

The dredging fleet remained in winter quarters in the Kentucky River until March 7, when it was towed to Cincinnati by the snag boat *E. A. Woodruff* for annual repairs, which were begun on March 11 and finished on May 26.

The principal items of repairs on the *Ohio* were to the main engines, on which the old 10 inch by 15 inch cylinders were replaced by new ones 12 inches by 15 inches, and to the crane-swinging cylinder, which was fitted with a friction brake. The *Oswego* was fitted with independent engines for the aft spud hoist, new gear wheels for the main engines, and a 6 inch by 6 inch engine to run the repair machinery, besides having such general overhauling as was considered advisable for the old machinery, which was so badly worn and shaken that complete repair could not be made without practically rebuilding it.

The dredge *Ohio*, since the remodeling in 1896, shows so great an increase in efficiency, probably 50 per cent, that a similar change on the *Oswego* is earnestly recommended. A detailed estimate for remodeling the *Oswego* was included in my annual repairs estimate of December 29, 1897.

Guyandotte Bar, 303 miles below Pittsburg.—The channel 125 feet wide, which was dredged through the bar just below the upper dike in 1895, proved too narrow because boats were obliged to make the crossing to the Ohio shore just above it. The new channel was therefore widened to 250 feet through the upper bar, a distance of 1,350 feet, making sufficient room for packets and tows at all stages.

Excavation made June 1 to 29: Hard gravel, shale, bowlders, etc., 23,491 cubic yards.

Craigs Bar, 537.5 miles below Pittsburg.—Dredging at this place was a continuation of the improvement begun in 1896, when a channel 90 feet wide was dredged through the bar on the Kentucky side of the river, the crooked channel on the Indiana side having been closed by two stone dikes. A large part of the excavation was in cemented gravel, the removal of which severely taxed the power of the dredges' machinery. During about one-half of July the work was stopped by high water, and in September it was seriously interrupted by the low stage of river; but the new channel, 4,400 feet long, with minimum width of 220 feet and center depth of 5 feet below low

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water, was finished, the material excavated being used to strengthen the dikes and to fill up the old channel between them.

During the lower stages almost the entire discharge of the river is now through the new channel, which furnishes safe and easy passage through what was formerly the most troublesome bar between Cincinnati and Louisville. The current, though strong at the lower end, is so straight that boats run the new chute very easily, and packets have no difficulty in passing each other in it.

Excavation made July 10 to September 25:

	Cu. yds.
Cemented gravel	45,365
Gravel and sand	35,641
Logs and gravel	1,298
Total	82,304

Snags removed September 17 to 29, 104; 39.3 tons.

Madison Harbor, Indiana, 552.5 miles below Pittsburg.—It was expected that after completion of the new channel at Craigs Bar the dredges would be employed to widen and straighten the channel at Cullums Ripple or at Gunpowder Bar, but as the river had become too low to permit their working at either of these places, the fleet was taken to Madison to widen the channel by dredging off the gravel bar opposite the dike, where the conditions were such that favorable results could be attained even at the lowest stages of river. Dredging was continued until November 9, when the river rose sufficiently to permit work at points above.

The dredging at Madison widened the channel 260 feet, making, at the narrowest place, which is opposite the lower end of the dike, a channel width of 380 feet. The extreme length of area dredged is 2,810 feet, the depth being 5 feet below low water.

The work has made a safe channel for tows as well as packets, and the increased body of water thus directed into the channel will no doubt tend to prevent recurrence of the sand reef, which often formed across the channel below the wharf boat.

Excavation made October 1 to November 9: Gravel, 58,599 cubic yards.

Snags removed, 1; .2 ton.

Rising Sun Bar, 502 miles below Pittsburg.—While on the way from Madison to Cullums the dredges were stopped at Rising Sun Bar to remove the gravel lump left in the channel, when they were obliged to go into winter quarters in 1893, and also to build a spur of hard gravel on the right bank above the root of the lower dike.

The spur was made by banking, next to the shore, one cut 415 feet long, the object being to deflect the current toward a sand bar which had formed in the channel opposite the lower dike. The river has not since been low enough to show what effect was attained.

The lump in the channel below the upper dike was dredged off, and as the river remained too high for work at Cullums and other points above, the dredges continued to widen the channel at the middle bar, below the upper dike, until December 2, when operations were stopped by high water, and the fleet was ordered into winter quarters at Carrollton.

Excavation made November 15 to December 2: Gravel, 18,220 cubic yards.

Snags removed, 1; 1.1 tons.

Respectfully submitted.

E. J. CARPENTER, *Assistant Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

OHIO RIVER DREDGING STATEMENT FOR 1897.

Dredges in commission.

TIME.

Time at work.	Days.	Time lost.	Days.
Dredging gravel and sand	51.9	Sundays	27
Dredging cemented gravel	20.5	Holidays	4
Dredging hard gravel, shale bowlders, etc.	14.8	High and low water	29.5
Dredging logs and gravel	1.3	Traveling	12.7
Removing snags	1.8	Accidents	28.5
		Fog and wind	3
Total	90.3	Total	104.7

Total in commission, 195 days.

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Dredges in commission—Continued.

WORK.

Nature of work.	Per day of work.	During season.
	Cu. yds.	*Cu. yds.*
Gravel and sand excavated	2,136.8	112,378
Cemented gravel excavated	2,212.9	45,365
Hard gravel, shale, bowlders, etc., excavated	1,592.8	23,573
Logs and gravel excavated	998.5	1,298
Total excavation for the season		182,614

Snags removed (weighing 39.7 tons), 105.

Cost.

Equipment:	
Per day in commission	$5.98
Per day of work	12.92
For the season	1,166.46
Towing and fuel:	
Per day in commission	29.71
Per day of work	64.16
For the season	5,794.06
Repairs:	
Per day in commission	4.65
Per day of work	10.04
For the season	906.35
Salaries:	
Per day in commission	45.12
Per day of work	97.43
For the season	8,798.35
Total cost:	
Per day in commission	85.46
Per day of work	184.55
For the season	16,665.22

Dredges out of commission.

TIME.

	Days.
In ordinary	93
Annual repairs	77
Total	170

COST.

Salaries in ordinary	$1,358.99	
Total in ordinary		$1,358.99
Salaries during annual repairs	$3,686.74	
Annual repairs (shop bills, materials, etc.)	2,342.46	
Total cost of repairs		6,029.20
Total out of commission		7,388.19
Cost per day in ordinary (including superintendent's pay)		14.61

Cost of work, including all expenditures, in 1897.

Dredging gravel and sand	$13,824.72
Dredging cemented gravel	5,460.63
Dredging hard gravel, shale, bowlders, etc	3,942.31
Dredging logs and gravel	346.28
Removing snags	479.47
Total expenditure in 1897	24,053.41

Cost per unit.

Per cubic yard of gravel and sand	$0.123
Per cubic yard of cemented gravel	0.120
Per cubic yard of hard gravel, shale, bowlders, etc	0.167

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Per cubic yard of logs and gravel	$0.267
Per day in commission	123.35
Per day of work	266.37
Per cubic yard excavated	0.129

The *day of work* is for ten hours, actual operation of the 2 dredges, with 4 dump scows and 1 towboat for tender, after taking out all time lost by accident or otherwise.

The towboat *Bob Ballard*, chartered as dredge tender, was paid $30 per day, this amount covering the cost of the boat, with outfit, crew, and fuel for the towboat and dredges, except that all cost of coal in excess of 5 cents per bushel was repaid by the Government.

The "total expenditure" includes all outlay incurred on account of the dredging fleet, except the amount, $1,194, paid for construction of a decked flatboat, the cost of which is not properly chargeable to one season.

Place.	From Pittsburg.	Date.	Days of work.	Kind of work.	Logs and snags.	
					No.	Tons.
	Miles.	1897.				
Guyandotte Upper Bar.	303.0	June	14.3	Dredging hard gravel, shale bowlders, etc.	.....	.....
Craigs Bar	537.0 to 538.0	July to September.	17.8	Dredging gravel and sand	.....	.....
Do	537.0 to 537.7	July to September.	20.5	Dredging cemented gravel	.....	.....
Do	538.0	September	1.3	Dredging logs and gravel	.....	.....
Do	538.0	.....do	1.7	Removing snags	104	39.3
Brooksburg, Ind	546.3	.....do	0.1	.....do	1	0.4
Madison Harbor, Ind	552.5	October to November.	25.5	Dredging gravel and sand	.....	.....
Rising Sun Bar	502.0	November to December.	7.6	.....do	.....	.....
Do	502.0	November	1.0	Banking gravel and sand for spur.	.....	.....
Do	501.5	.....do	0.5	Dredging gravel and rock for riprap dike.	.....	.....
Total	.....	.....	90.3	.....	105	39.7

Place.	Excavation.					
	Gravel and sand.	Cemented gravel.	Hard gravel, shale, bowlders, etc.	Logs and gravel.	Per day of work.	Cost per cubic yard.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	
Guyandotte Upper Bar	.....	.....	23,491	.....	1,642.7	$0.162
Craigs Bar	35,641	.....	.....	.....	2,002.3	.133
Do	.....	45,365	.....	.....	2,212.9	.120
Do	.....	.....	.....	1,298	998.5	.267
Do	.....	.....	.....	.....	.....	.....
Brooksburg, Ind	.....	.....	.....	.....	.....	.....
Madison Harbor, Ind	58,599	.....	.....	.....	2,298.0	.116
Rising Sun Bar	15,768	.....	.....	.....	2,074.7	.128
Do	2,370	.....	.....	.....	2,370.0	.112
Do	.....	.....	82	.....	164.0	1.624
Total	112,378	45,365	23,573	1,298	.....	.....

Place.	Expenditures.					
	Removing logs and snags.	Dredging gravel and sand.	Dredging cemented gravel.	Dredging hard gravel, shale, bowlders, etc.	Dredging logs and gravel.	Total for 1897.
Guyandotte Upper Bar	.....	.....	.....	$8,809.12	.....	$8,809.12
Craigs Bar	.....	$4,741.43	.....	.....	.....	4,741.43
Do	.....	.....	$5,460.63	.....	.....	5,460.63
Do	.....	.....	.....	.....	$346.28	346.28
Do	$452.83	.....	.....	.....	.....	452.83
Brooksburg, Ind	26.64	.....	.....	.....	.....	26.64
Madison Harbor, Ind	.....	6,792.49	.....	.....	.....	6,792.49
Rising Sun Bar	.....	2,024.43	.....	.....	.....	2,024.43
Do	.....	266.37	.....	.....	.....	266.37
Do	.....	.....	.....	133.19	.....	133.19
Total	479.47	13,824.72	5,460.63	8,942.31	346.28	34,053.41

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REPORT OF MR. A. B. M'GREW, SURVEYOR, ON HARBOR LINES.

IRONTON, OHIO, *June 30, 1898.*

MAJOR: I have the honor to submit the following report of the work done under my charge during the fiscal year ending June 30, 1898.

Cincinnati Harbor lines.—The field work on this survey was resumed October 5, and continued to November 13; office work from November 14 to November 20, completing the marking of these harbor lines.

The party in the field consisted of myself as surveyor, with three assistants.

The work was carried out in accordance with verbal instructions received from Maj. W. H. Heuer, which required that the harbor lines be marked by the use of reference points; these reference points to be placed on various buildings, bridge piers, etc., such as were best calculated for future identification of the lines. The distances from these reference points were measured and placed on the map of Cincinnati Harbor. The elevation of each reference point and the elevation of the harbor line opposite each reference point was also placed on the map. The harbor line on the left bank of the river was marked from the Newport Water Works to Andersons Landing. (Work on the left bank was completed prior to July 1, 1897.)

Wheeling Harbor lines.—Field work on this survey was resumed December 3 and continued to January 31, and from May 24 to May 31; office work from February 1 to February 7, 1898.

The party in the field December 3 to January 31, consisted of myself as surveyor, with three assistants, and from May 24 to May 31, of myself as surveyor, with four assistants.

This work was carried on in the same general way as that on the Cincinnati Harbor lines. In addition to the work of making the harbor lines, and in accordance with instructions received from your office, both banks of the river were examined for encroachments. Each apparent encroachment was separately reported to you by letter, with a sketch showing the location of the encroachment. Later these sketches were supplemented by the addition of sections showing the nature of the encroachments.

The harbor line was marked on the right bank of the river from Martins Ferry Water Works, Martins Ferry, Ohio, to the Belmont Coal Company's Works, Bellaire, Ohio; and on Wheeling and Boggs islands. (The work on the left bank was completed prior to July 1, 1897.)

* * * * * * *

Pittsburg Harbor lines.—Field work on this survey began March 24 and continued to May 23.

The party in the field consisted of myself as surveyor, with four assistants.

The work was carried on in the same general way as that on the harbor lines at Cincinnati, Ohio, and Wheeling, W. Va., except that the work was done under the supervision of William Martin, assistant engineer. In accordance with instructions received from your office, special attention was given to the matter of encroachments on the harbor lines. Each apparent encroachment was reported to you through Mr. Martin, by letter, with a plan accompanying showing the location and nature of the encroachment.

The harbor lines were marked on the right bank of the river from Union Bridge, Allegheny, to Davis Island Dam; on the left bank from Point Bridge, Pittsburg, to a point opposite Davis Island, and on Brunot Island.

Survey at Ironton, Ohio.—In accordance with instructions received from your office, I, with a party of five, proceeded to Ironton, Ohio, to make a careful local survey of the Ohio River, such as is necessary for the establishment of harbor lines.

The field work was begun June 1, and is now in progress. Stations have been marked on the right bank of the river from a point about 2 miles south of Coal Grove, Ohio, to Hanging Rock, Ohio, and on the left bank from the Ashland Water Works, Ashland, Ky., to a point near (Post Light No. 173) Hanging Rock Point, Kentucky; base line on the right bank was measured from Ashland Water Works, Ashland, Ky., for a distance of 9 miles.

Respectfully submitted.

A. B. MCGREW, *Surveyor.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

NINE MILE TO FOUR MILE BARS.

[Extract from report of Mr. R. R. Jones, assistant engineer.]

Recommendation for continuing the improvement of the Ohio River from Nine Mile Bar to Four Mile Bar, inclusive, being that portion of the river between 451¼ and 458 miles below Pittsburg.

This section of the river has been exceedingly bad for many years.

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In 1886 a crib dike was constructed at Eight Mile Bar. This dike curves outward from the Kentucky shore, is about 2,300 feet in length. and cuts off about 575 feet, measured at right angles from the Kentucky shore. The dike reaches to about an 8-foot stage of water. This work failed to greatly benefit the river, and in 1892 two loose stone dikes were built. These dikes effected considerable improvement in their immediate vicinity, and in 1895 another loose stone dike was partly built, which, although not entirely completed, has effected an improvement in the channel.

The river bed at this point consists almost entirely of gravel, sometimes very closely compacted, and the particles bonded together with some cementing substance, either lime or iron. At the upper end the river passes from a deep pool into shoals and swifter water, extending for a length of about 8,900 feet, and emerges into another pool not so deep nor extensive as the upper one.

Of the two shores, that on the right-hand bank (Ohio) is composed of gravel, both loose and compacted, and at the lower end some rock. The left-hand (Kentucky) bank is generally soft material, sand and alluvium. Immediately outside the end of projected dike No. 1 is situated the very worst portion of the channel, and at this place, in 1895, the steamer *M. P. Wells* lay aground for six or seven weeks. During extreme low stages but little water is wasted through the channel between dry bar and Ohio shore, but at a stage of about 1 foot above extreme low water the river flows over the bar and a greatly increased volume comes down the back channel.

Projected improvement.—The contraction of the channel to 600 feet in width, which should give a central depth of about 7 feet. This involves the construction of 4 dikes extending out from the Ohio shore. Of these, one lies in the river proper, while the other three cross the back channel and the dry bar, with short ends in main river. These dikes it is proposed to make of loose stone, 10 feet wide at top and to extend 2 feet above extreme low water.

On the Kentucky shore it is proposed to construct shore projections opposite three of the above dikes, these to be of the same general character as the shore ends of the opposite dikes. These are intended to prevent erosion of the shore.

It is further proposed to complete the dike which was partially built in 1895.

Five Mile Bar.—Previous to 1895 there were no dikes at Five Mile Bar, but between October 17 and November 25, 1895, three loose stone dikes were constructed, one on the Kentucky side and two on the Ohio side. The one on the Kentucky side was completed to a length of 225 feet from the shore at low water. The other two were but partly completed. The material used in the construction of the dike on the Kentucky side was blasted rock taken from the mouth of Licking River and conveyed therefrom to the site of the dike. The material used in the two dikes on Ohio side was rock and some of the coarser gravel taken from a cut made by dredging. This cut, at Five Mile Bar, was made between October 24 and November 24, 1895.

At Five Mile Bar the river bed consists of gravel, loose rock, and a little sand—borings show no rock in place. The loose rock is mostly sandstone, and in size from 1 cubic foot to half a cubic yard or more. The gravel is fine and does not appear to be cemented.

Four Mile Bar.—There are three timber-crib dikes at Four Mile, known on the records as follows: "Upper Ohio Four Mile Dike," built in 1880-81; "Kentucky Four Mile Dike," built in 1880-81; "Lower Ohio Four Mile Dike," built in 1884-85. These three dikes are curved outward from the shore, and consist of pile and stone substructure surmounted by timber crib work about 20 feet wide and filled with stone.

The result obtained from the construction of the crib dikes at Four Mile Bar has not been entirely satisfactory. The channel is generally shallow, tortuous, and shifting, and does not appear to be improved by the continuous action of the dikes. Opposite the "Kentucky Four Mile Dike" a bar consisting of gravel and sand has been formed by the sinking of one or more barges or flatboats, portions of which were visible during the low water of 1895.

There are detached pools of good depth, separated by shallows, all the way from Six Mile to the deep water below the last crib dike. Opposite the lower Ohio dike the bars seem to be composed mostly of sand. On the Kentucky shore are several points projecting into the deep-water channel in such a way as to make passage around them difficult for boats during low water.

Projected improvement of Five Mile and Four Mile bars.—The contraction of the channel to 600 feet in width, which should give a central depth of about 7 feet. To accomplish this, it is proposed to complete the two dikes on the Ohio side at Five Mile and extend the one on Kentucky side 80 feet, to meet the channel line; then to construct a number of intermediate dikes and shore protections from the head of Five Mile to the foot of Four Mile bars. It is further proposed to deepen and straighten the channel through these bars by dredging, the material dredged up to be used in constructing the proposed dikes.

The cost of these dikes and dredging is estimated at $80,000, of which $63,000 can be spent advantageously each fiscal year until the work is completed.

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ROCK BAR AT MOUTH OF LICKING RIVER.

[Extract from report of Mr. R. R. Jones, Assistant Engineer.]

Recommendation for continuing the excavation through the bar at mouth of Licking River, in the Ohio River.

The entrance to the Licking River is obstructed by a large bar in the Ohio River, extending along the Kentucky shore above and below the mouth, covering, in all, some 48 acres, and leaving a narrow but sufficiently deep channel on the Ohio side along the water front of Cincinnati. This bar has obstructed navigation for many years, but in 1884 even the shallow channel, which the Licking held through it up to that time, became filled up as a result of a freshet, and since 1884 navigation on the Licking has been completely cut off at low-water stages. This bar consists of limestone rock ledges more or less overlaid with loose rock, sand, and gravel.

The project for the improvement of the mouth of the Licking contemplated the cutting of a channel through the bar from a point within the Licking, where a good depth of water prevailed, to the navigable water in the Ohio, this improved channel to have a depth of 4 feet at extreme low water, and a mean width of about 200 feet.

The plant for the submarine blasting of the solid rock ledges and general method of conducting the work is described in Annual Report, Chief of Engineers, fiscal year ending June 30, 1894, Part III, pages 1845-1847. This method has proved very economical in comparison with excavation by cofferdam.

The present condition of the improvement is such that navigation interests do not derive much benefit, and will not until a cut is carried through the worst portion of the bar.

The cost of this work as here proposed is estimated at $78,000, of which $35,000 can be spent advantageously each fiscal year until the work is completed.

F F 2.

OPERATING SNAG BOAT ON THE OHIO RIVER.

The act of Congress making a yearly appropriation of $25,000 for this work is quoted in the Annual Report for 1896, Part IV, page 2093, which also states the object of the work, and the probable greater efficiency secured by the river and harbor act of 1896, which increased the yearly amount available from $25,000 to $50,000. This increase in appropriation allows of more continuous operations than in former years.

July 1, 1897, the boat was in commission, working from Madison, Ind., upstream. Continued low water preventing the snag boat from reaching Pittsburg, she worked downstream to Paducah, where a sudden rise compelled the boat to tie up from August 2 to 9. Operations were resumed on August 9, working downstream to the confluence of the Ohio and Mississippi rivers. She was then headed upstream, arriving at Cincinnati August 24. Here she was engaged in removing obstructions from the harbor. On September 25 the snag boat was laid up, owing to extreme low water, the crew being employed in general work about the boat. There were removed during the season 623 snags, 85 piling, 6 steamboats, 2 hulls, 22 barges, flats, etc., 70 cubic yards rock, 2 drift piles, and other obstructions.

Continued low water last fall exposed many obstructions in the river that required immediate removal. This was undertaken on October 20 by a hired steamer and wrecking boat manned by a part of the snag-boat crew; 118 snags and 1 pile of rocks were removed.

The wreck of the city wharf boat, and also the wreck of a crane boat, at Mt. Vernon, Ind., were removed by a part of the snag-boat crew—both wrecks being complained of as obstructions to navigation. Hercules powder was used in this work.

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On November 1, 1897, a contract was entered into with The Cincinnati Marine Railway Company for replating hull of snag boat. The boat was docked on December 9, but no work was done until January 5, 1898. The very high water of the winter months interfered materially with the work, which, at the end of the fiscal year, is nearing completion.

Repairs of a minor character are being made by hired labor, while the boat is receiving the hull plating.

The operations of the snag boat have been carried on with great thoroughness and efficiency by Mr. W. H. Christian, master, whose report, giving details of the work, is herewith appended.

Detailed statement of expenditures for operating snag boat on the Ohio River during the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	For what paid.	Amount.
	July, 1897.		
94	Swift & Co	Meats, etc	$85.77
95	Middleton & Wymond Co	Coal	55.25
96	The Hamilton Grocery Co	Groceries	65.76
97	The Joseph R. Peebles' Sons Co	Flour and macaroni	15.88
98	Geo. Story	Vegetables	12.40
100	W. H. Brown's Son	Coal	52.00
149	Tony Meldahl	Traveling expenses	5.15
151	T. H. Davis	Meat, ice, and milk	15.83
152	The Consolidated Boat Store Co	Ice and groceries	18.59
153	Ernest Horschel	Fresh meat	51.12
162	Silver Run Coal Co	Coal	33.74
166	J. I. Marsh	Ice	9.96
168	Jos. P. Schaefer	Vegetables, etc	7.05
186	The Western Union Telegraph Co	Telegram	.20
187	do	do	.22
188	do	do	.20
191	Pay roll	Service	100.00
	Total		529.12
	August, 1897.		
17	Pay roll	Service	1,290.00
18	do	do	507.92
19	do	do	229.63
20	Thomas S. Sandford	Traveling expenses	2.90
24	Frank Weber	Meat and milk	31.18
26	Means, Kyle & Co	Coal	90.00
36	Weil, Brockman & Co	Potatoes and apples	26.00
37	Western Union Telegraph Co	Telegram	.20
40	The Hamilton Grocery Co	Groceries	114.95
50	The Chas. Moser Co	Sponge	20.00
51	P. Emrich	Lamb	6.30
61	The Joseph R. Peebles' Sons Co	Groceries	102.55
62	Swift & Co	Meats, etc	83.17
63	Geo. Story	Vegetables	11.85
64	Middleton & Wymond Co	Coal	50.00
65	H. A. Cook & Son	Vegetables, oils, etc	12.73
79	Langstaff-Orm Manufacturing Co	Fenders, etc	11.27
80	Holt & Brandon Ice and Cold Storage Co	Ice	5.00
86	The Consolidated Boat Store Co	Ice, groceries, etc	38.34
87	Ohio Valley Coal and Mining Co	Coal	32.00
90	The Devere Electric Co	Service and material	2.00
100	John Mattan & Bro	Wharfage	2.00
101	John L. Westbay	Traveling expenses	4.75
107	Ohio Valley Coal and Mining Co	Coal	28.92
108	Fowler, Crumbaugh & Co	Provisions, etc	101.54
110	Western Union Telegraph Co	Telegram	.20
111	Postal Telegraph Cable Co	do	.20
114	Jas. Griffith & Sons	White pine	15.50
117	Cumberland Coal Co	Coal	41.80
118	H. A. Cook & Son	Vegetables, etc	26.81
119	Holt & Brandon Ice and Cold Storage Co	Ice	9.75
120	P. Emrich	Meat	39.48
122	Simon Ice Manufacturing Co	Ice	9.00
138	Pay roll	Service	125.00
141	do	do	1,208.00
142	do	do	252.55
143	do	do	498.16
	Total		5,021.15

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Detailed statement of expenditures for operating snag boat on the Ohio River during the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	For what period.	Amount.
	September, 1897.		
16	Scott Paris	Traveling expenses	$4.25
29	C. Crane & Co	Wharfage	2.00
38	Middleton & Wymond Co	Coal	25.00
39	J. F. Wells	Vegetables, etc	6.07
49	M. H. Bans	Fresh meat	20.08
50	Swift & Co	Meats, etc	38.99
56	Pay roll	Service	5.00
58	The Marietta Ice Co	Ice	6.00
60	Bergenroth Bros	Coal	24.00
61	A. H. Dugan	....do	22.00
62	The Joseph R. Peebles' Sons Co	Groceries	24.83
63	The Hamilton Grocery Co	....do	6.97
64	The Pickering Hardware Co	Door springs	.30
65	The McIlvain & Speigel Boiler and Tank Co	Steel	2.46
69	Eureka Tackle Block Manufactory	Sheave	2.25
70	E Sweeney	Service and watering pot	2.10
71	Licking Coal and Towboat Co	Coal	42.00
74	Swift & Co	Meats	66.55
75	The Hamilton Grocery Co	Groceries	16.70
77	The Consolidated Boat Store Co	Groceries, etc	22.92
82	W. H. Brown's Son	Coal	4.00
89	The Western Union Telegraph Co	Telegrams	.45
112	Belmont Coal Co	Coal	44.00
114	The Western Union Telegraph Co	Telegram	.22
124	Geo. Story	Vegetables	15.10
125	Weil, Brockman & Co	....do	22.13
198	Licking Coal and Towboat Co	Coal	40.32
200	The Pickering Hardware Co	Rivets	.65
208	The John Ingle Coal Co	Coal	10.50
220	The Lunkenheimer Co	Valves, etc	2.41
263	The Consolidated Boat Store Co	Provisions, ice, and dynamite	62.19
264	W. H. Brown's Son	Coal	105.18
286	John Mattan & Bro	Wharfage	3.00
293	Swift & Co	Meats	46.57
297	Thos. J. Nichol & Co	Bushing and ells	.50
298	Globe Rolling Mill Iron and Steel Co	Bar iron	7.17
299	Geo. Story	Vegetables	12.40
302	Pay roll	Service	125.00
	Total		852.26
	October, 1897.		
1	Pay roll	Service	1,277.07
2	....do	....do	500.21
3	....do	....do	138.00
10	....do	....do	1.38
24	....do	....do	2.00
45	The Consolidated Boat Store Co	Ice and milk	6.04
46	Swift & Co	Meats	21.15
48	Geo. Story	Vegetables	6.10
49	W. H. Brown's Son	Coal	70.00
76	Pay roll	Service	12.83
114	Geo. Story	Vegetables, etc	5.62
115	The Consolidated Boat Store Co	Ice and milk	8.51
116	The Hamilton Grocery Co	Groceries	9.58
117	The Joseph R. Peebles' Sons Co	Flour and crackers	5.09
134	Globe Rolling Mill Iron & Steel Co	Iron	3.12
148	Swift & Co	Meats	26.97
160	John Mattan & Bro	Wharfage	10.75
	Total		2,105.02
	November, 1897.		
5	Pay roll	Service	1,429.49
6	....do	....do	20.83
9	....do	....do	125.00
50	W. H. Christian	Street-car fares	4.45
57	Swift & Co	Meats	42.78
60	The Hamilton Grocery Co	Groceries	6.30
61	The Joseph R. Peebles' Sons Co	....do	10.09
69	John Mattan & Bro	Wharfage	3.00
70	Geo. Story	Vegetables, etc	12.70
71	Crawley & Johnston	Packing rings	4.00
78	Geo. Story	Vegetables, etc	5.92
79	Barron, Boyle & Co	White lead	5.00
80	Swift & Co	Meats	23.27
94	The Joseph R. Peebles' Sons Co	Groceries	12.46
104	The Hamilton Grocery Co	....do	46.39

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Detailed statement of expenditures for operating snag boat on the Ohio River during the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	November, 1897—Continued.		
105	The Joseph R. Peebles' Sons Co	Groceries	$49.23
106	C. P. Wagner & Co	Oil	3.90
154	Swift & Co	Meats, etc	49.56
163	The Webb Stationery and Printing Co	Job printing	29.71
178	Louisville Courier-Journal Co	Advertisement	8.22
179	The Sayings Co	do	2.45
191	Alonzo Kenison	Traveling expenses	2.50
192	The Cincinnati Times-Star Co	Advertisement	4.50
193	The Dispatch Publishing Co	do	4.20
194	Geo. Story	Vegetables, etc	17.18
196	The Consolidated Boat Store Co	Groceries and supplies	59.11
205	Pay roll	Service	.83
222	do	do	320.83
	Total		2,303.85
	December, 1897.		
64	C. Whithorn	Rubber stamps	.70
80	John Mattan & Bro	Wharfage	12.50
175	Thomas Donovan	Traveling expenses	1.15
176	George Beyersdorfer	do	1.15
203	James Frooks	do	2.50
P 204	The C. F. Bradley Co	Stationery, etc	2.20
207	John Mattan & Bro	Wharfage	18.50
208	Licking Coal and Towboat Co	Towage	10.00
212	Edward Brasil	Traveling expenses	3.30
213	C. W. Glaser	do	1.15
214	Albert W. Phillips	do	1.15
P 225	The Pickering Hardware Co	Bolts	.30
235	Pay roll	Service	125.00
253	do	do	449.33
	Total		628.93
	January, 1898.		
25	Pay roll	Service	15.75
136	do	do	142.58
P 185	do	do	125.00
186	do	do	489.13
	Total		772.46
	February, 1898.		
57	C. P. Wagner & Co	Oil	3.94
115	The Marmet Co	Coal	17.30
P 120	Pay roll	Service	125.00
121	do	do	400.00
	Total		546.24
	March, 1898.		
72	Postal Telegraph Cable Co	Telegram	.20
97	Pay roll	Service	.45
P 100	Oscar W. Kuhn	do	.40
112	Pay roll	do	528.50
	Total		529.55
	April, 1898.		
P 8	Pay roll	Service	125.00
21	Barron, Boyle & Co	Oil, lead, and brushes	54.69
73	Durrell Bros	Rubber boots	10.14
	Total		189.83
	May, 1898.		
14	Pay roll	Service	657.58
P 21	do	do	125.00
P 30	W. H. Stanage & Co	Stationery, etc	1.90
P 32	C. Whithorn	Rubber stamps	1.75
57	Pay roll	Service	9.00
75	The Cincinnati Transfer Co	Drayage	18.00
89	W. H. Christian	Street car fares	14.25
94	The Cincinnati Marine Railway Co	Service and material	2,686.40
	Total		3,513.88

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Detailed statement of expenditures for operating snag boat on the Ohio River during the fiscal year ending June 30, 1898—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	June, 1898.		
P 1	Pay roll	Service	$125.00
2	do	do	1,097.79
59	do	do	35.00
P 74	W. H. Stanage & Co	Stationery, etc	2.85
94	Barron, Boyle & Co	Red lead, wire brushes	23.20
107	The Pickering Hardware Co	Material	21.50
109	The Queen City Coal Co	Coal	3.50
112	C. Whithorn	Rubber stamps	.70
P 192	Pay roll	Service	125.00
	Total		1,434.54

Summary of expenditures for operating and care of snag boat on the Ohio River for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$3,715.89
Labor	9,193.44
Subsistence	1,657.91
Fuel	786.51
Expenses	264.76
Repairs	2,808.32
Total	18,426.83

Abstract of proposals for replating hull of U. S. snag boat E. A. Woodruff, received in response to advertisement dated August 14, 1897, and opened at Cincinnati, Ohio, October 14, 1897, by Second Lieut. W. B. Ladue for Maj. W. H. Bixby, Corps of Engineers.

No.	Name of bidder.	Steel in place on boat (price per pound).	Docking and launching, complete.	Location of ways.	Date of—	
					Commencement.	Completion.
1	The Cincinnati Marine Railway Co. a	*Cents.* 7 7/10	$3,200	Cincinnati, Ohio ..	About Dec. 1, 1897.	About May 1, 1898.

a Recommended for acceptance.

CONTRACT.

A contract for replating the hull of the U. S. snag boat *E. A. Woodruff* was entered into November 1, 1897, with the Cincinnati Marine Railway Company, and approved November 22, 1897; to commence about December 1, 1897; to be completed May 1, 1898; extended to August 9, 1898.

REPORT OF CAPT. W. H. CHRISTIAN, MASTER OF SNAG BOAT.

U. S. SNAG BOAT E. A. WOODRUFF,
Cincinnati, Ohio, June 30, 1898.

MAJOR: I have the honor to submit herewith my annual report of operations of the U. S. snag boat *E. A. Woodruff*, and for other work incidental to the removal of snags, wrecks, etc., from the Ohio River for the fiscal year ending June 30, 1898:

July 1, 1897, the U. S. snag boat *E. A. Woodruff* left Madison, Ind., headed upstream, and worked as far as Millwood, W. Va., 229 miles below Pittsburg, arriving July 9. The river then being quite low and falling, with unfavorable reports about water above, the *Woodruff* was therefore headed downstream, after removing the snags in that vicinity, and worked as far as Portsmouth, Ohio, 353½ miles below Pittsburg, arriving July 14. At this point another rise was reported above and at Pittsburg, and the snag boat was again headed upstream, hoping to reach Pittsburg on the rise. On reaching Fish Creek Island, 112 miles below Pittsburg, July 17, the river was found to be falling and too low to proceed farther with safety; therefore, after remov-

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ing all obstructions in the vicinity, the snag boat was headed downstream, removing obstructions en route as far as Paducah, Ky., 920 miles below Pittsburg, arriving August 2. Here a sudden rise in the river obliged the snag boat to tie up from August 2 to 9. On the latter date the river had fallen to a working stage, and the snag boat resumed operations as far as the confluence of the Ohio and Mississippi rivers. From here the snag boat turned back and worked upstream, arriving at Cincinnati August 24. From August 26 to September 24 she was employed removing wrecks, snags, piling, etc., between the mouth of Little Miami River, 400, and Maxwell, Ky., 500 miles below Pittsburg.

On September 25 the snag boat was laid up on account of low water, and from that date to October 21 the crew was employed repairing the boat's rigging, preparing her for hauling out on the ways, and arranging her property for warehouse storage while the boat was undergoing authorized repairs.

From October 21 to 31 part of the *Woodruff's* crew continued work on the boat. The remainder was assigned to duty on the steamers *Fairplay* and *Little Vic*, hired for public service October 20, 1897. On October 31 all employees then engaged on the snag boat, except the master and two watchmen, who remained to look after the boat and property, were furloughed without pay until their services were again required.

Repairs to the hull and other parts contingent thereto were authorized by the Chief of Engineers January 19, 1897, but it was considered advisable to defer their commencement, which, it was estimated, would require about six months' time to complete, until the following winter months, when the boat would have to lie up for cold weather, and because this plan would permit the snag boat to perform her regular work during the season of 1897.

The principal repair required was to the hull plating of the boat, which (except the new plates put on the new sections and the old plates cleaned and painted when the snag boat was lengthened in the spring of 1885) had been exposed to continuous corrosive action of the river water from March, 1875, to December, 1897; consequently the plates were deeply pitted all over, and in many places were rust eaten clear through, causing many leaks.

In addition to repairing the hull the following-named repairs were authorized and will be made as fast as the replating work will permit, viz, paddle wheels, capstan machinery, well roller, spars, stage, etc., wheel houses, exhaust pipes, new A frame, and painting.

On November 1, 1897, a contract was entered into with The Cincinnati Marine Railway Company to replate the hull of the snag boat *Woodruff*, the work to be commenced about December 1, 1897, and to be completed May 1, 1898.

The snag boat was hauled out on the Cincinnati Marine Railway at Cincinnati, Ohio, December 9, 1897, but no work was done on the contract until January 5, 1898, due to the late date of finishing a warehouse for the proper and safe storage of the snag boat property during the period of repairs to the boat.

January 5, 1898, the contractors commenced the removal of the stern-rake plating, but their operations were stopped by a rise in the river on January 13, 1898.

On January 23 high water floated the snag boat off her blocks with all the stern-rake plating removed.

From January 23 to February 27 the snag boat lay at the bank waiting a fall of the river and vacation of the ways, the contractors having taken another boat on the ways for repairs after the snag boat floated off. On February 27 the snag boat was again hauled out on the ways and blocked up to release the cradles, and the removal of old materials was resumed and the placing of new commenced.

On March 23 work was again interrupted by high water, and operations on the iron work were suspended until April 8, when the river had fallen sufficiently to permit a resumption of work. Since then work has been continued without interruption, and about three-fourths of the new hull plating and many new and repaired angle irons have been put in place.

During the latter rise the snag boat was submerged to a depth of 15 feet 2 inches, which left a 6-inch deposit of mud in the hull compartments and on the main deck, machinery, etc., and filled completely some of the small engine cylinders and water and steam pipes, the cleaning of which involved much expense.

Report of operations of the steamer Fairplay and wrecking boat Little Vic.—October 20, 1897, the steamer *Fairplay* and wrecking boat *Little Vic* were chartered to take the place of the snag boat *Woodruff*, to remove some dangerous obstructions very much complained of, which the snag boat could not reach on account of low water.

Between October 20 and November 12, the steamer *Fairplay*, in command of Mr. W. H. Christian, and manned by part of the *Woodruff's* crew, and towing the wrecking boat *Little Vic*, left Cincinnati and ran down as far as Greens Landing, 496 miles below Pittsburg, and commenced and continued the removal of reported obstructions between this point and Pomeroy. No obstructions being reported above Pomeroy, the boats were turned downstream November 13, removing obstructions the presence of which was unknown and unobserved on the up trip, and also a pile

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of rock from the head of Conoconneque Bar which had been left there by the owners of a wrecked stone boat. Arrived at Cincinnati, Ohio, November 18. On the 19th the services of the steamer *Fairplay* and *Little Vic* were discontinued and they were turned over to their owners and their hire stopped.

Snags removed ..... number.. 118
1 rock pile ..... cubic yards.. 30
Snags removed ..... tons.. 441

Removal of wharf-boat wreck at Mount Vernon, Ind.—From December 22 to 30, 1897, inclusive, Floyd McMeans, mate of the snag boat *E. A. Woodruff*, and two men sent from Cincinnati, with three men employed at Mount Vernon, removed, by blasting, the large city wharf-boat wreck sunk on the public landing at that place. In removing this wreck, 480¼ pounds of Hercules powder, in 116 explosions, was expended.

Removal of crane-boat wreck at Mount Vernon, Ind.—From June 13 to 20, 1898, inclusive, Mate McMeans, and two laborers sent from Cincinnati, Ohio, to Mount Vernon, Ind., with two other men employed there, removed, by blasting, the wreck of a sunken crane boat which had been long complained of by river men as a serious obstruction to navigation. Expended 362 pounds Hercules powder, in 88 explosions, in the removal of this wreck.

Time.

	Days.	
In commission March 5 to 12 and May 21 to October 31, 1897—		
At work and running, including three Sundays	103	
At Cincinnati, making repairs, taking stores, and waiting a rise	40	
At Paducah waiting a fall in the river	5	
Sundays tied up	21	
Holidays laid up	3	
		172
In ordinary:		
January 1 to March 4 and March 13 to April 6, 1897	88	
November 1 to December 31, 1897	61	
		149
Annual repairs, April 7 to May 20, 1897		44
Total days		365

During the working season of 1897 the snag boat traveled 4,039¼ miles.

Obstructions removed during 1897 by the U. S. snag boat *E. A. Woodruff:* 623 snags, 4,225 tons; 85 piling; 29 pieces square timber and 27 boards; 1 steamer, *Sidney Dillon;* 1 steamer, *B. S. Rhea;* 1 steamer, *Scotia;* 1 steamer, *Longfellow;* 1 steamer, *Peankishaw No. 108;* 1 steamer, *Kate Timmonds;* 2 steamer hulls (names unknown); 19 coal boats, barges, and flats; 1 sand boat; 1 stone boat; 1 brick boat; 1 steamboat shaft; 2 boilers, steam and mud drum attached, steamer *Vesper;* 1 rudder; 3 pieces coal-barge wrecks; 5 rocks, 70 cubic yards; 2 drift piles, 250 cubic yards; 18 breaks dragged over; 1 grounded boat assisted.

Snags of 50 tons and over removed and their location at the time of removal.

Place.	Miles below Pittsburg.	Tons.
Sunfish Ripple	117¼	68.300
Channel below Mill Creek	229¼	51.300
Channel front Shiveleys Landing	279	76.083
Channel above old mouth Scioto River	355	65.033
Channel front Wycoffs Landing	360½	58.666
Channel front Crawfish Creek	462½	59.800
Channel front Rock Springs Distillery	750	58.666
Do	750	54.480
Do	750	75.420
Do	750	69.400
Channel front Muds Landing	751½	53.066
Channel front Three Mile Island	771½	125.166
Do	771½	74.640
Channel front Posey Landing	780	52.333
Channel front Lamberts Landing	852½	108.960

Respectfully submitted.

W. H. CHRISTIAN,
Master U. S. snag boat E. A. Woodruff.

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

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F F 3.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PENNSYLVANIA.

The lock and Chanoine dam were in good condition through the year and caused no interruption to navigation.

The new lock gates, put in operation during the last fiscal year, have proved successful, except the valve-operating device, which requires some modification to make it work easily. Two boilers were fitted up and put in place to provide additional steam for the lock-gate engines.

It is found that the following works at this locality are in very bad condition and will require renewal: The fixed timber dam, between Davis Island and the south bank; the guide walls of lock, and the water tanks used in storing water for operating hydraulic valve-jacks. A dike is also required to close a made channel on Davis Island.

The dam was raised 6 times and lowered 5.

Commercial statistics for this work are included in those relating to the Ohio River proper.

The work has been under the efficient supervision of Mr. William Martin, resident engineer, whose report is appended.

Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.

The following is a statement of the amounts and dates of all allotments for this work:

August 3, 1885	$5,865.00	June 27, 1893	$1,300.00
July 10, 1886	12,015.00	July 22, 1893	12,253.82
January 28, 1887	6,700.00	July 18, 1894	12,459.02
July 1, 1887	12,355.00	May 25, 1895	450.00
February 25, 1888	3,500.00	July 9, 1895	30,661.54
July 11, 1888	18,015.00	July 28, 1896	15,531.57
August 20, 1889	12,073.00	May 17, 1897	1,200.00
May 14, 1890	2,000.00	July 23, 1897	9,898.62
July 17, 1890	14,752.00	November 20, 1897	400.00
October 7, 1890	14,800.00		
July 10, 1891	10,338.00	Total	208,399.05
July 21, 1892	11,831.48		

Detailed statement of expenditures for operating and care of canals and other works of navigation applied to Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	For what paid.	Amount.
	July, 1897.		
48	Pay roll	Service	$503.33
74	The C. F. Bradley Co	Letter-copy book	2.00
112	Andrew J. Morse & Son	Diving dress	40.75
113	Hulings Bros	Sand and gravel	133.38
114	do	Hire of flatboats	54.00
116	The Freedom Oil Works Co	Oil	5.04
122	The Central District and Printing Telegraph Co.	Rent of telephone	142.50
124	H. Turk	Service	2.80
125	L. C. Rodibaugh	do	3.20
126	L. K. Gabler	do	3.20
127	A. F. McGowan	do	8.00
128	Chas. D. Gillespie	do	7.50
129	John C. O'Donnell, postmaster	Rent of post-office box	2.00
130	W. B. Rodgers	Coal	121.23
135	E. G. Caughey & Co	Cement	42.25
142	Alexander McClure Co	Oak and pine lumber	30.00

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Detailed statement of expenditures for operating and care of canals and other works of navigation applied to Davis Island Dam, Ohio River, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	July, 1897—Continued.		
143	Caskey Boat Store Supply Co	Material	$10.79
144	Bellevue and Glenfield Natural Gas Co	Natural gas	87.50
150	The Western Union Telegraph Co	Telegrams	9.62
154	W. B. Rodgers	Service	300.00
172	Thomas Carlin's Sons	Service and material	117.40
	Total		1,626.49
	August, 1897.		
11	Pay roll	Service	700.00
22	Samuel McKnight	Material, etc	13.10
23	The Central District and Printing Telegraph Co.	Telegrams	8.60
29	Mike Coughlin	Service	1.80
35	Edward Roberts	do	17.48
	Total		740.98
	September, 1897.		
21	Pay roll	Service	440.00
51	A. F. McGowan	do	3.50
52	Baker Chain and Wagon Iron Manufacturing Co.	Iron chain	98.94
53	J. & H. Phillips	Duck and leather belt	1.51
119	The C. F. Bradley Co	Letter file	.90
126	Alexander McClure Co	Pine lumber	125.75
136	Wm. G. Johnston & Co	Blank forms, etc	12.20
189	The Freedom Oil Works Co	Oil	9.30
190	Caskey Boat Store Supply Co	Material, etc	45.09
192	W. B. Rodgers	Towage	5.00
267	Samuel McKnight	Saw blades, etc	2.50
268	Scaife Foundry and Machine Co., Limited	Spur wheels	47.06
270	W. W. Lawrence & Co	Paint	30.83
	Total		822.58
	October, 1897.		
8	Pay roll	Service	642.59
53	Samuel McKnight	Gauge glasses, etc	1.09
143	Bellevue and Glenfield Natural Gas Co	Natural gas	87.50
152	Chas. D. Gillespie	Service	45.00
153	L. K. Gabler	do	18.40
154	L. C. Rodibaugh	do	18.40
155	H. Turk	do	18.40
186	John C. O'Donnell, postmaster	Rent of post-office box	2.00
	Total		833.38
	November, 1897.		
38	Pay roll	Service	440.00
138	The Western Union Telegraph Co	Telegrams	56.83
139	The Central District and Printing Telegraph Co.	do	42.60
	Total		539.43
	December, 1897.		
1	Pay roll	Service	640.00
120	Thomas Carlin's Sons	Service and material	192.44
123	W. A. Bunting & Son	Rubber stamps	2.27
P 125	Wm. H. Bixby	Mileage	.61
130	Wm. G. Johnston & Co	Stationery	2.07
134	Samuel McKnight	Material, etc	10.18
177	Thomas Carlin's Sons	Service and material	22.77
185	Caskey Boat Store Supply Co	Oil	4.40
191	Wilson Snyder Manufacturing Co	Piston rod, etc	23.50
219	H. Turk	Service	15.00
220	L. C. Rodibaugh	do	15.20
232	L. K. Gabler	do	17.80
252	Chas. D. Gillespie	do	37.50
	Total		983.74
	January, 1898.		
19	Pay roll	Service	440.00
44	James Bowman	Gas lamps	12.10
109	Bellevue and Glenfield Natural Gas Co	Natural gas	87.50
123	Thomas Carlin's Sons	Nipple	.63
135	The Central District and Printing Telegraph Co.	Rent of telephone	142.50
159	Western Union Telegraph Co	Telegrams	50.20

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Detailed statement of expenditures for operating and care of canals and other works of navigation applied to Davis Island Dam, Ohio River, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	January, 1898—Continued.		
179	Caskey Boat Store Supply Co	Material, etc	$15.80
182	John C. O'Donnell, postmaster	Rent of post-office box	2.00
	Total		750.73
	February, 1898.		
14	Pay roll	Service	640.00
110	The Freedom Oil Works Co	Oil	7.69
116	The Central District and Printing Telegraph Co.	Telegrams	31.40
	Total		679.09
	March, 1898.		
10	Pay roll	Service	440.00
50	The Mansfield Manufacturing Co., Limited	Pipe and fittings	8.60
108	Thomas Carlin's Sons	Services of machinist	3.00
	Total		451.60
	April, 1898.		
7	Pay roll	Service	640.00
27	James Bowman	Lamp chimneys and mantels	6.50
44	Wm. H. Bixby	Mileage	25.54
66	Bellevue and Glenfield Natural Gas Co	Natural gas	87.50
87	Jos. Eichbaum & Co	Record book	7.75
95	John C. O'Donnell, postmaster	Rent of post-office box	2.00
	Total		769.29
	May, 1898.		
16	Pay roll	Service	440.00
25	Pullman's Palace Car Co	Sleeping-car fare	4.00
42	Sam'l G. Church & Co	Services and material	43.00
61	The Baltimore and Ohio Southwestern Rwy Co.	Transportation	7.35
72	Cook & Fair	Lumber	50.85
	Total		545.20
	June, 1898.		
36	Pay roll	Service	640.00
61	Baltimore and Ohio R. R. Co	Transportation	7.35
88	The Freedom Oil Works Co	Oil	7.83
126	Joseph Woodwell & Co	Material	1.20
131	Chas. Munson Belting Co	Rubber hose and packing	78.90
133	Wm. H. Bixby	Mileage	25.84
176	T. C. Marshall	Oak stain and putty	1.05
	Total		762.17

Summary of expenditures for operating and care of Davis Island Dam, Ohio River, for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$1,416.77
Labor	5,499.82
Fuel	383.73
Expenses	938.86
Repairs	1,265.50
Total	9,504.68

REPORT OF MR. WILLIAM MARTIN, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bellevue, Pa., June 30, 1898.

MAJOR: I have the honor to submit the following report for operating and care of Davis Island Dam, Ohio River, for the fiscal year ending June 30, 1898:

The new lock gates, which are of the caisson type, are built of steel and have been in operation one year. These gates replaced wooden ones, which were in use twelve

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years and badly decayed. Parts of the design in the old gates were found defective, and they were omitted in the new ones. The practical operation of the new gates has met our anticipations, except the mechanism for operating the valves, which requires some modification to make them work with facility. When the gates were first put in operation they worked stiffly, but now that the journals have adjusted themselves to their bearings, they work freely. The steam capacity of both the upper and lower lock-gate engines was increased by an additional boiler for each gate. These boilers were on hand and were no additional cost to the United States. The lock-gate engines and other operating machinery of the lock are in good condition.

The Chanoine and bear-trap movable dams have been in good condition throughout the year. No repairs were necessary, and there were no delays to navigation from any cause in connection therewith.

The fixed dam between Davis Island and the south bank of the river was built in 1883, to cut off the water from passing down the back channel. It is a timber dam, 457 feet long, and is composed of frames, or bents, placed 5 feet apart, with the faces planked close. The upper face has an inclination of 30 degrees and the lower face of 60 degrees with the horizontal; the interior is filled with stone. The dam has been built fifteen years, and in many of its parts is greatly deteriorated. The principal members of the structure are so rotten that bolts or spikes will no longer hold. The timber cribs at each end of the dam are also decaying and falling into the river. It will be necessary to reconstruct this dam in another year.

The guide walls of the lock are undergoing the natural deterioration; both the upper and lower walls are in bad condition. As cited in the last Annual Report, nothing short of an entire renewal would justify any expenditure.

The water tanks used for storing water for operating the hydraulic valve-jacks and for other purposes have been built for thirteen years. The timber of the supports has become very much decayed, so much so as to endanger the safety of the structure. When the tanks are full there is a head of 62 feet, which does not give sufficient power when the head on the lock valves exceeds 5 feet. The tanks, however, can only be carried about half full, as it is not considered safe to fill them. We can operate them about another year, when it will be advisable to substitute an accumulator instead of erecting similar tanks, both on account of the lack of head and the cost of plant.

The waters from the ravine, opposite the upper gate recess, are conducted under the railroad tracks, through a 3-inch by 4-inch rectangular culvert, discharging in the inclosure back of the upper guide wall. This culvert is inadequate to carry the contents of the run, and in times of heavy rains it becomes choked by débris which is carried from the ravine. Eventually the inclosure back of the guide wall will become filled up, and some plan should be devised to carry the waters of this run into the river through the wall.

On Davis Island, fronting the main channel, and about 200 feet above the dam, an excavation was made for procuring material for cofferdam during the construction of the dam. This excavation has been converted into a channel, and during stages of 10 feet and upward it forms an island. This channel should be closed by a dike, to prevent further deepening and to reclaim the land. An item has been inserted in the annual estimate for this purpose.

The supply of natural gas for fuel and light has been received, as heretofore, from the Bellevue and Glenfield Natural Gas Company, at the same rate paid for several years.

The maneuvers of the dam have been as follows: The dam was down at the beginning of the fiscal year, was raised June 12, lowered July 20, raised August 4, lowered August 18, raised August 21, lowered November 16, raised November 23, lowered November 27, 1897, and raised June 2, lowered June 15, and raised June 17, 1898.

Respectfully submitted.

WILLIAM MARTIN, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 4.

MOVABLE DAMS IN OHIO RIVER.

For the projects and operations for these works reference is made to the Annual Reports of the Chief of Engineers for 1891, page 2354; 1896, page 2100; 1897, page 2358.

Movable Dam No. 6, near Beaver, Pa.—Work on the navigable pass

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at the beginning of the year was in progress under contract with Hulings Brothers, of Pittsburg, Pa., approved April 29, 1897, for the construction of the Chanoine dam and masonry pier. The cofferdam, begun June 2, 1897, which had been planned to inclose the entire work, was, by order of June 30 from the Chief of Engineers, reduced in length 125 feet, in order to increase the channel way to the width considered requisite by coal and tow boat interests for safe navigation. This change necessitated the removal of some piling and a stone crib already placed and the rebuilding of the crib.

Excavation for foundation was begun in August, followed by pile driving for grillage. Excavation to the required depth disclosed a stratum of loose gravel, which was considered unsafe for foundation, and sheet piling was accordingly driven on the upstream side to a depth of 15 feet below bottom reference of the concrete foundation.

The work was continued, interrupted by much delay in receipt of materials, until the middle of November, when high water made it necessary to flood the cofferdam and suspend operations. Up to this date there had been completed: The excavation for foundations, about 500 feet of sheet piling on upstream face of concrete, extension of concrete for 336 feet to a height of 6 inches below the subsleepers, setting of 193 anchor bolts, and driving of all piling for grillage, the placing of all joists, and of nearly all cap timbers. At this time the indifference and delay of the contractor had become so serious that it was manifestly necessary to resort to the provisions of paragraph 106 of the contract, whereby the officer in charge is empowered to employ men and purchase materials in order to "put the work in proper advancement or condition." Pursuant to authority granted by the Chief of Engineers, under date of November 15, 1897, this course was adopted, but owing to the prevalence of high water little was accomplished. On November 18 an execution by outside parties was issued on the contractor's property. A few days later he made an assignment, and nothing has since been done by him.

Operations by the Government were resumed in April, 1898, and at the close of the year 125 wickets had been completed, a large quantity of timber prepared for the foundation when ready, 320 feet of cofferdam, carried away by winter floods, replaced, and all preparatory work on operating machinery completed.

Work on the lock during the year was done largely by hired labor, and consisted of completing all timber facing on the lower guiding wall and for a height of 5 feet on the upper wall, a small quantity of concrete work, and a flight of stone steps. Work on dredging the approaches to the lock was carried on until stopped by high water in December, the excavated material being deposited in the guiding-wall inclosures.

With the view of completing the entire movable part of the dam during the present working season a project was submitted June 9, 1898, modifying a project approved July 27, 1897, for the weirs to close the remaining 360 feet of river between the Chanoine dam and the abutment on the left bank by the substitution of one span of A-frame dam for one of the three bear-trap dams therein authorized. By Special Order No. 12, Headquarters Corps of Engineers, dated June 16, 1898, this subject was referred to a Board of Engineer Officers for consideration, whose report now awaits action by the Department.

The commercial statistics relating to this work are included in those for the Ohio River.

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Summaries of the work done and its cost, both by contract and under charge of this office, are given below.

Movable Dams Nos. 2, 3, 4, and 5.—At the beginning of the year the land for Dam No. 2 and part of that for No. 4 had been purchased. Since that date the acquisition of all land required for sites has been completed except one tract of 1.5 acres at No. 5, which awaits approval of deed by the Department of Justice, and one tract of 0.141 acre obtained by condemnation proceedings, the award for which also awaits approval.

Under the appropriation of $400,000 contained in the sundry civil act approved June 4, 1897, a project was approved by the Secretary of War July 28, 1897, for the construction of Lock No. 2, discarding the proposed batter of lock walls. Subsequently the Chief of Engineers stated that Congress, by its action with reference to Dams 2–5, intended that continuing contracts covering the entire work, to the extent permitted by the limit of contract fixed by law, should be arranged for immediately, and, as the locks and dams were of different classes of work, it was permissible to make contracts for the locks, to be followed by contracts for the dams as soon as plans and specifications could be prepared, and he therefore directed that the specifications for Lock No. 2 be modified to include Locks 3, 4, and 5. Pursuant to these instructions, proposals for the construction of the four locks were opened October 26, 1897, and a contract for each awarded to Eigenmann & Hollerbach and Eichel & Arnold, of Evansville, Ind. As the titles to the sites at No. 3 and No. 5 are incomplete, no work has been done on these locks. On Nos. 2 and 4 work was commenced in April by the erection and placing of plant. The cofferdam at No. 2 was begun in April and that at No. 4 in May. At the former a stratum of solid rock was discovered, and pile driving was consequently discontinued.

At the end of the year the material expended on these works and its cost is as follows:

Chanoine dam.—Work under contract of Hulings Bros.

Framing timber	linear feet	1,196
Temporary piling	do	4,606
Permanent piling	do	16,590
Air conduit	do	325
Electric conduit	do	320
Earth filling	cubic yards	8,632
Stone filling	do	2,470
Common excavation	do	6,910
Concrete	do	2,483
Sheeting	feet B. M.	28,500
Sheet piling	do	33,718
Timber in permanent construction	do	141,464
Screw and drift bolts	pounds	57,118
Cast-iron washers	do	9,737

The cost of the above work was $40,375.79.

Lock No. 6.—Work under agreement with W. B. Rodgers.

White-oak timber furnished and erected	feet B. M.	3,588
White-oak timber erected	do	61,612
Driftbolts	pounds	4,626
Screw bolts and washers	do	1,173
Sawed stone for steps	square feet	144
Portland concrete	cubic yards	42½
Gravel excavation	do	7,863

The cost of the above work was $5,355.37.

The cost of the work done by Eigenmann & Hollerbach and Eichel & Arnold, on Locks Nos. 2 and 4, was $1,925.22.

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Temporary buildings for use as offices at these sites have been contracted for at a cost of about $457 for No. 2 and $482 for No. 4.

This work has been carried on with great thoroughness and efficiency by Mr. William Martin, resident engineer, whose report, giving the progress of the work in detail, is herewith appended.

Money statements.

CONSOLIDATED.

July 1, 1897, balance unexpended		$832,820.37
Amount appropriated by sundry civil act approved July 1, 1898		595,000.00
		1,427,820.37
June 30, 1898, amount expended during fiscal year		90,188.90
July 1, 1898, balance unexpended		1,337,631.47
July 1, 1898, outstanding liabilities	$7,781.13	
July 1, 1898, amount covered by uncompleted contracts	882,125.41	
		889,906.54
July 1, 1898, balance available		447,724.93
Amount (estimated) required for completion of existing project		1,975,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

DAMS 2, 3, 4, AND 5.

July 1, 1897, balance unexpended		$429,948.61
Amount appropriated by sundry civil act approved July 1, 1898		595,000.00
		1,024,948.61
June 30, 1898, amount expended during fiscal year		24,169.07
July 1, 1898, balance unexpended		1,000,779.54
July 1, 1898, outstanding liabilities	$676.83	
July 1, 1898, amount covered by uncompleted contracts	823,305.70	
		823,982.53
July 1, 1898, balance available		176,797.01
Amount (estimated) required for completion of existing project		1,975,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

DAM NO. 6.

July 1, 1897, balance unexpended		$402,871.76
June 30, 1898, amount expended during fiscal year		66,019.83
July 1, 1898, balance unexpended		336,851.93
July 1, 1898, outstanding liabilities	$7,104.30	
July 1, 1898, amount covered by uncompleted contracts	58,819.71	
		65,924.01
July 1, 1898, balance available		270,927.92

The following is a statement of the amount and date of all appropriations for this work:

September 19, 1890, construction of Lock and Dam No. 6	$250,000
July 13, 1892, construction of Lock and Dam No. 6, and purchase of land for No. 2	*100,000

*The bill provides that so much of this money as may be necessary may be used in making survey for location of Dam No. 2, and acquiring title to the land. The survey has been made and the land purchased.

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August 18, 1894, construction of Lock and Dam No. 6	$75,000
March 2, 1895, construction of Lock and Dam No. 6	150,000
June 3, 1896, construction of Lock and Dam No. 6	25,000
June 3, 1896, construction of Locks and Dams Nos. 2, 3, 4, and 5, and purchase of land for Nos. 3, 4, and 5	* 30,000
June 4, 1897, construction of Dams 2, 3, and 4	400,000
June 4, 1897, construction of Dam No. 6	300,000
July 1, 1898, continuing construction of Dams 2, 3, 4, and 5	595,000
Total	1,925,000
June 3, 1896, authorizes contracts for complete construction of Dams Nos. 2, 3, 4, 5, and 6	2,325,000
June 4, 1897, modifies above in relation to Dams Nos. 2, 3, 4, and 5, and authorizes contracts for partial construction up to	2,000,000

Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, received in response to advertisement dated September 23, 1897, and opened at Cincinnati, Ohio, October 26, 1897, by Maj. Wm. H. Bixby, Corps of Engineers.

LOCK NO. 2.

No. of proposal.	Name and address of bidder.	Cofferdam (1,500 linear feet).		Piling (6,118 linear feet).		Common excavation (53,084 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$12.00	$18,000.00	$0.30	$1,835.40	$0.90	$47,775.60
2	C. I. McDonald, Pittsburg, Pa	11.50	17,250.00	.29	1,774.22	.40	21,233.60
3	Jolly & Harrold, Beaver Falls, Pa	15.00	22,500.00	.30	1,835.40	.55	29,196.20
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va	10.00	15,000.00	.40	2,447.20	.35	18,579.40
5	Kaufman & Estrada, Pittsburg, Pa	28.00	42,000.00	.37	2,263.66	.44	23,356.96
7	McIlvain, Unkefer Co., Pittsburg, Pa	18.12	27,180.00	.60	3,670.80	.55	29,196.20
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	9.30	13,950.00	.40	2,447.20	.38	20,171.92
9	William B. Rodgers, Pittsburg, Pa	9.87	14,805.00	.35	2,141.30	.49	26,011.16
10	Heldmaier & Neu, Chicago, Ill	12.00	18,000.00	.37	2,263.66	.40	21,233.60
11	Joseph Gianini, Pittsburg, Pa	2.25	3,375.00	.30	1,835.40	.48	25,480.32
12	I. V. Hoag, jr., Pittsburg, Pa	18.00	27,000.00	.40	2,447.20	.70	37,158.80
13	McArthur Bros. Co., Chicago, Ill	12.00	18,000.00	.32	1,957.76	.40	21,233.60
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	7.00	10,500.00	.30	1,835.40	.15	7,962.60

No. of proposal.	Name and address of bidder.	Concrete masonry (30,726 cubic yards).		Ashlar masonry (1,918 cubic yards).		Rubble masonry (504 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$4.90	$150,557.40	$13.60	$26,084.80	$6.75	$3,402.00
2	C. I. McDonald, Pittsburg, Pa	3.75	115,222.50	11.00	21,098.00	4.00	2,016.00
3	Jolly & Harrold, Beaver Falls, Pa	5.25	161,311.50	10.00	19,180.00	4.00	2,016.00
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va	4.65	142,875.90	10.00	19,180.00	6.00	3,024.00
5	Kaufman & Estrada, Pittsburg, Pa	4.70	144,412.20	15.00	28,770.00	5.00	2,520.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	4.33	133,043.58	12.18	23,361.24	4.50	2,268.00
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	3.59	110,306.34	8.75	16,782.50	4.00	2,016.00
9	William B. Rodgers, Pittsburg, Pa	4.69	144,104.94	12.90	24,742.20	5.90	2,973.60
10	Heldmaier & Neu, Chicago, Ill	3.40	104,468.40	13.65	26,180.70	6.80	3,427.20
11	Joseph Gianini, Pittsburg, Pa	5.75	176,674.50	10.25	19,659.50	5.50	2,772.00
12	I. V. Hoag, jr., Pittsburg, Pa	4.85	149,021.10	18.00	34,524.00	9.00	4,536.00
13	McArthur Bros. Co., Chicago, Ill	4.35	133,658.10	12.00	23,016.00	6.00	3,024.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	3.00	92,178.00	10.00	19,180.00	5.40	2,721.60

*The bill provides that $20,000, or so much thereof as may be necessary, may be used for purchase of sites for Dams Nos. 3, 4, and 5, and, if not sufficient, so much of the moneys heretofore appropriated for Dam No. 6 as may be requisite may be used for this purpose.

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Coping masonry (1,077 cubic yards).		Brick masonry (629 cubic yards).		Oak timber in permanent construction (388,550 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$25.00	$26,925.00	$10.00	$6,290.00	$32.00	$12,433.60
2	C. I. McDonald, Pittsburg, Pa.....	19.00	20,463.00	7.00	4,403.00	27.50	10,685.13
3	Jolly & Harrold, Beaver Falls, Pa.	15.00	16,155.00	7.50	4,717.50	35.00	13,599.25
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va..	20.00	21,540.00	9.00	5,661.00	33.00	12,822.15
5	Kaufman & Estrada, Pittsburg, Pa.	27.50	29,617.50	8.00	5,032.00	40.00	15,542.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	12.81	13,796.37	10.12	6,365.48	37.13	14,426.86
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.....	16.50	17,770.50	7.00	4,403.00	30.00	11,656.50
9	William B. Rodgers, Pittsburg, Pa.	16.90	18,201.30	12.90	8,114.10	43.00	16,707.65
10	Heldmaier & Neu, Chicago, Ill	20.25	21,809.25	10.15	6,384.35	39.30	15,270.01
11	Joseph Gianini, Pittsburg, Pa	15.00	16,155.00	7.95	5,000.55	55.00	21,370.25
12	I. V. Hoag, jr., Pittsburg, Pa	18.00	19,386.00	15.00	9,435.00	60.00	23,313.00
13	McArthur Bros. Co., Chicago, Ill..	18.00	19,386.00	9.50	5,975.50	46.00	17,873.30
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	13.60	14,647.20	8.40	5,283.60	36.00	13,987.80

No. of proposal.	Name and address of bidder.	Pine timber in permanent construction (48,600 feet B. M.).		Hemlock timber in permanent construction (246,400 feet B. M.).		Gravel or earth filling (53,000 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$35.00	$1,701.00	$20.00	$4,928.00	$0.60	$31,800.00
2	C. I. McDonald, Pittsburg, Pa	37.50	1,822.50	20.00	4,928.00	.25	13,250.00
3	Jolly & Harrold, Beaver Falls, Pa.	33.00	1,603.80	22.00	5,420.80	.40	21,200.00
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va..	35.00	1,701.00	18.00	4,435.20	.40	21,200.00
5	Kaufman & Estrada, Pittsburg, Pa.	40.00	1,944.00	30.00	7,392.00	.40	21,200.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	30.38	1,476.47	19.12	4,711.17	.31	16,430.00
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	31.00	1,506.60	15.50	3,819.20	.24	12,720.00
9	William B. Rodgers, Pittsburg, Pa.	45.00	2,187.00	24.50	6,036.80	.59	31,270.00
10	Heldmaier & Neu, Chicago, Ill	36.25	1,761.75	19.60	4,829.44	.35	18,550.00
11	Joseph Gianini, Pittsburg, Pa.....	55.00	2,673.00	24.00	5,913.60	.40	21,200.00
12	I. V. Hoag, jr., Pittsburg, Pa.....	50.00	2,430.00	40.00	9,856.00	.60	31,800.00
13	McArthur Bros. Co., Chicago, Ill..	32.00	1,555.20	20.00	4,928.00	.28	14,840.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	36.00	1,749.60	20.00	4,928.00	.20	10,600.00

No. of proposal.	Name and address of bidder.	Framing timber (4,416 linear feet).		Stone filling (2,018 cubic yards).		Cast iron (176,083 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$0.20	$883.20	$2.00	$4,036.00	$0.035	$6,162.91
2	C. I. McDonald, Pittsburg, Pa.....	.19	839.04	2.00	4,036.00	.0275	4,842.28
3	Jolly & Harrold, Beaver Falls, Pa.	.12	529.92	1.50	3,027.00	.03	5,282.49
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va..	.20	833.20	3.00	6,054.00	.03	5,282.49
5	Kaufman & Estrada, Pittsburg, Pa.	.30	1,324.80	2.50	5,045.00	.04	7,043.32
7	McIlvain, Unkefer Co., Pittsburg, Pa	.18	794.88	1.13	2,280.34	.03½	5,869.43
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.....	.30	1,324.80	2.50	5,045.00	.032	5,634.66
9	William B. Rodgers, Pittsburg, Pa.	.29	1,280.64	2.15	4,338.70	.0295	5,194.45
10	Heldmaier & Neu, Chicago, Ill	.35	1,545.60	3.70	7,466.60	.03	5,282.49
11	Joseph Gianini, Pittsburg, Pa.....	.40	1,766.40	2.00	4,036.00	.025	4,402.08
12	I. V. Hoag, jr., Pittsburg, Pa	.30	1,324.80	2.00	4,036.00	.05	8,804.15
13	McArthur Bros. Co., Chicago, Ill..	.25	1,104.00	1.85	3,733.30	.025	4,402.08
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	.20	883.20	.96	1,937.28	.0375	6,603.11

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Wrought iron (78,715 pounds).		Structural steel (194,144 pounds).		Bolt holes (1,000 linear feet).		Total amount of bid.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
1	Jutte & Foley Co., Pittsburg, Pa	$0.035	$2,755.02	$0.045	$8,736.48	$0.20	$200.00	$354,506.41
2	C. I. McDonald, Pittsburg, Pa	.0325	2,558.24	.035	6,795.04	.35	350.00	253,566.55
3	Jolly & Harrold, Beaver Falls, Pa	.035	2,755.02	.04	7,765.76	.40	400.00	318,495.64
4	The Smyth & Munford Contracting Co., Point Pleasant, W. Va	.04	3,148.60	.04	7,765.76	.30	300.00	291,890.90
5	Kaufman & Estrada, Pittsburg, Pa	.04	3,148.60	.04	7,765.76	.50	500.00	348,877.80
7	McIlvain, Unkefer Co., Pittsburg, Pa	.04	3,148.60	.04	7,765.76	.20	200.00	295,985.18
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.	.032	2,518.88	.032	6,212.61	.25	250.00	238,535.71
9	William B. Rodgers, Pittsburg, Pa	.0395	3,109.24	.0495	9,610.13	.39	390.00	221,218.21
10	Heldmaier & Neu, Chicago, Ill	.03	2,361.45	.07	13,590.08	.50	500.00	274,924.58
11	Joseph Gianini, Pittsburg, Pa	.025	1,967.88	.035	6,795.04	.50	500.00	321,576.52
12	L. V. Hoag, jr., Pittsburg, Pa	.05	3,935.75	.05	9,707.20	.60	600.00	379,315.09
13	McArthur Bros. Co., Chicago, Ill	.04	3,148.60	.035	6,795.04	.25	250.00	284,880.48
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.0375	2,931.81	.0375	7,280.40	.28	280.00	205,509.60

Recommended for award to No. 14, Eigenmann & Hollerbach and Eichel & Arnold.

LOCK NO. 3.

No. of proposal.	Name and address of bidder.	Cofferdam (1,500 linear feet).		Piling (6,118 linear feet).		Common excavation (53,084 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$10.00	$15,000.00	$0.30	$1,835.40	$0.80	$42,467.20
2	C. I. McDonald, Pittsburg, Pa	11.00	16,500.00	.35	2,141.30	.40	21,233.60
3	Jolly & Harrold, Beaver Falls, Pa	15.00	22,500.00	.30	1,835.40	.55	29,196.20
7	McIlvain-Unkefer Co., Pittsburg, Pa	26.50	39,750.00	.60	3,670.80	.29	15,394.36
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	9.30	13,950.00	.40	2,447.20	.38	20,171.92
9	William B. Rodgers, Pittsburg, Pa	9.87	14,805.00	.35	2,141.30	.49	26,011.16
10	Heldmaier & Neu, Chicago, Ill	12.00	18,000.00	.37	2,263.66	.40	21,233.60
11	Joseph Gianini, Pittsburg, Pa	2.00	3,000.00	.33	2,018.94	.50	26,542.00
12	L. V. Hoag, jr., Pittsburg, Pa	18.00	27,000.00	.40	2,447.20	.70	37,158.80
13	McArthur Bros. Co., Chicago, Ill	12.00	18,000.00	.32	1,957.76	.40	21,233.60
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	7.00	10,500.00	.30	1,835.40	.15	7,962.60

No. of proposal.	Name and address of bidder.	Excavation in rock (1,000 cubic yards).		Concrete masonry (30,726 cubic yards).		Ashlar masonry (1,918 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$2.00	$2,000.00	$4.50	$138,267.00	$12.60	$24,166.80
2	C. I. McDonald, Pittsburg, Pa	3.00	3,000.00	3.75	115,222.50	11.00	21,098.00
3	Jolly & Harrold, Beaver Falls, Pa	2.00	2,000.00	5.25	161,311.50	10.00	19,180.00
7	McIlvain-Unkefer Co., Pittsburg, Pa	1.50	1,500.00	4.11	126,283.86	15.20	29,153.60
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	1.50	1,500.00	3.49	107,233.74	8.75	16,782.50
9	William B. Rodgers, Pittsburg, Pa	1.50	1,500.00	4.47	137,345.22	12.90	24,742.20
10	Heldmaier & Neu, Chicago, Ill	.75	750.00	3.30	101,395.80	13.15	25,221.70
11	Joseph Gianini, Pittsburg, Pa	1.75	1,750.00	5.90	181,283.40	11.00	21,098.00
12	L. V. Hoag, jr., Pittsburg, Pa	2.00	2,000.00	4.85	149,021.10	18.00	34,524.00
13	McArthur Bros. Co., Chicago, Ill	2.00	2,000.00	4.30	132,121.80	12.00	23,016.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	1.00	1,000.00	3.00	92,178.00	10.00	19,180.00

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Rubble masonry (504 cubic yards).		Coping masonry (1,077 cubic yards).		Brick masonry (629 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$5.75	$2,898.00	$20.00	$21,540.00	$9.25	$5,818.25
2	C. I. McDonald, Pittsburg, Pa	4.00	2,016.00	19.00	20,463.00	7.00	4,403.00
3	Jolly & Harrold, Beaver Falls, Pa.	4.00	2,016.00	14.00	15,078 00	7.00	4,403.00
7	McIlvain-Unkefer Co., Pittsburg, Pa	5.00	2,520.00	26.20	28,217.40	11.25	7,076.25
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	4.00	2,016.00	16.50	17,770.50	7.00	4,403.00
9	William B. Rodgers, Pittsburg, Pa.	5.90	2,973.60	16.90	18,201.30	12.90	8,114.10
10	Heldmaier & Neu, Chicago, Ill	6.30	3,175.20	19.75	21,270.75	9.83	6,183.07
11	Joseph Gianini, Pittsburg, Pa.....	6.00	3,024.00	14.00	15,078.00	8.00	5,032.00
12	I. V. Hoag, jr., Pittsburg, Pa.....	9.00	4,536.00	18.00	19,386.00	15.00	9,435.00
13	McArthur Bros. Co., Chicago, Ill ..	6.00	3,024.00	17.50	18,847.50	9.50	5,975.50
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	5.40	2,721.60	13.60	14,647.20	8.40	5,283.60

No. of proposal.	Name and address of bidder.	Oak timber in permanent construction (388,550 feet B. M.).		Pine timber in permanent construction (48,600 feet B. M.).		Hemlock timber in permanent construction (246,400 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa ..	$32.00	$12,433.60	$32.00	$1,555.20	$18.00	$4,435.20
2	C. I. McDonald, Pittsburg, Pa	29.50	11,462.23	35.00	1,701.00	20.00	4,928.00
3	Jolly & Harrold, Beaver Falls, Pa.	35.00	13,599.25	33.00	1,603.80	22.00	5,420.80
7	McIlvain-Unkefer Co., Pittsburg, Pa	40.00	15,542.00	32.50	1,579.50	20.00	4,928.00
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	30.00	11,656.50	31.00	1,506.60	15.50	3,819.20
9	William B. Rodgers, Pittsburg, Pa.	43.00	16,707.65	45.00	2,187.00	24.50	6,036.80
10	Heldmaier & Neu, Chicago, Ill	38.80	15,075.74	35.75	1,737.45	19.10	4,706.24
11	Joseph Gianini, Pittsburg, Pa.....	55.00	21,370.25	55.00	2,673.00	24.00	5,913.60
12	I. V. Hoag, jr., Pittsburg, Pa	60.00	23,313.00	50.00	2,430.00	40.00	9,856.00
13	McArthur Bros. Co., Chicago, Ill ..	46.00	17,873.30	32.00	1,555.20	20.00	4,928.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	36.00	13,987.80	36.00	1,749.60	20.00	4,928.00

No. of proposal.	Name and address of bidder.	Gravel or earth filling (53,000 cubic yards).		Framing timber (4,416 linear feet).		Stone filling (2,018 cubic yards).		Cast iron (176,083 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$0.50	$26,500.00	$0.20	$883.20	$2.00	$4,036.00	$0.03	$5,282.49
2	C. I. McDonald, Pittsburg, Pa.....	.35	18,550.00	.19	839.04	2.00	4,036.00	.0275	4,842.28
3	Jolly & Harrold, Beaver Falls, Pa	.40	21,200 00	.12	529.92	1.25	2,522.50	.03	5,282.49
7	McIlvain-Unkefer Co., Pittsburg, Pa	.49	25,970.00	.18	794.88	2.19	4,419.42	.0325	5,722.70
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.	.24	12,720.00	.30	1,324.80	2.50	5,045 00	.032	5,634.66
9	William B. Rodgers, Pittsburg, Pa.....	.59	31,270.00	.29	1,280.64	2.15	4,338.70	.0295	5,194.45
10	Heldmaier & Neu, Chicago, Ill	.35	18,550.00	.35	1,545.60	3.00	6,054.00	.03	5,282.49
11	Joseph Gianini, Pittsburg, Pa	.55	29,150.00	.38	1,678.08	2.50	5,045.00	.025	4,402.08
12	I. V. Hoag, jr., Pittsburg, Pa.....	.60	31,800.00	.30	1,324.80	2.00	4,036.00	.05	8,804 15
13	McArthur Bros. Co., Chicago, Ill	.28	14,840.00	.25	1,104.00	1.50	3,027.00	.025	4,402.08
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.20	10,600.00	.20	883.20	.96	1,937.28	.0375	6,603.11

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Wrought iron (78,715 pounds).		Structural steel (194 144 pounds).		Bolt h[illegible] s (1,000 l[illegible] ar feet).		Total amount of bid.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
1	Jutte & Foley Co., Pittsburg, Pa	$0.03	$2,361.45	$0.04	$7,765.76	$0.20	$200.00	$319,445.55
2	C. I. McDonald, Pittsburg, Pa	.035	2,755.02	.0375	7,280.40	.35	350.00	262,821.37
3	Jolly & Harrold, Beaver Falls, Pa	.035	2,755.02	.04	7,765.76	.40	400.00	318,599.64
7	McIlvain-Unkefer Co., Pittsburg, Pa	.04	3,148.60	.04	7 765.76	.25	250.00	323,687.13
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.	.032	2,518.88	.032	6,212.61	.25	250.00	226,963.11
9	William B. Rodgers, Pittsburg, Pa	.0395	3,109.24	.0495	9,610.13	.39	390.00	315,958.49
10	Heldmaier & Neu, Chicago, Ill	.03	2,361.45	.07	13,590.08	.50	500.00	268,896.83
11	Joseph Gianini, Pittsburg, Pa	.025	1,967.88	.035	6,795.04	.50	500.00	338,321.27
12	I. V. Hoag, jr., Pittsburg, Pa	.05	3,935.75	.05	9,707.20	.60	600.00	381,315.00
13	McArthur Bros. Co., Chicago, Ill	.04	3,148.60	.035	6,795.04	.25	250.00	284,099.38
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.0375	2,951.81	.0375	7,280.40	.28	280.00	206,509.60

Recommended for rejection of all bids at present, and recommendation when site is acquired.

LOCK NO. 4.

No. of proposal.	Name and address of bidder.	Cofferdam (1,500 linear feet).		Piling (6,113 linear feet).		Common excavation (53,084 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$10.00	$15,000.00	$0.30	$1,835.40	$0.50	$26,542.00
2	C. I. McDonald, Pittsburg, Pa	10.00	15,000.00	.30	1,835.40	.30	15,925.20
3	Jolly & Harrold, Beaver Falls, Pa	15.00	22,500.00	.30	1,835.40	.50	26,542.00
6	Western Construction Co., Charleston, W. Va	16.58	24,870.00	.35	2,141.30	.40	21,233.60
7	McIlvain, Unkefer Co., Pittsburg, Pa	18.98	28,470.00	.66	4,037.88	.58	30,788.72
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	9.30	13,950.00	.40	2,447.20	.38	20,171.92
9	William B. Rodgers, Pittsburg, Pa	9.87	14,805.00	.35	2,141.30	.49	26,011.16
10	Heldmaier & Neu, Chicago, Ill	12.00	18,000.00	.37	2,263.66	.40	21,233.60
11	Joseph Gianini, Pittsburg, Pa	2.50	3,750.00	.40	2,447.20	.60	31,850.40
12	I. V. Hoag, jr., Pittsburg, Pa	18.00	27,000.00	.40	2,447.20	.70	37,158.80
13	McArthur Bros. Co., Chicago, Ill	12.00	18,000.00	.32	1,957.76	.36	19,110.24
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	7.00	10,500.00	.30	1,835.40	.15	7,962.60

No. of proposal.	Name and address of bidder.	Excavation in rock (1,000 cubic yards).		Concrete masonry (30,726 cubic yards).		Ashlar masonry (1,918 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa	$5 00	$5,000.00	$3.90	$119,831.40	$12.60	$24,166.80
2	C. I. McDonald, Pittsburg, Pa	3.00	3,000.00	3.25	99,859.50	10.50	20,139.00
3	Jolly & Harrold, Beaver Falls, Pa	2.00	2,000.00	5.25	161,311.50	10.00	19,180.00
6	Western Construction Co., Charleston, W. Va	3.00	3,000.00	4.20	129,049.20	11.00	21,098.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	1.50	1,500.00	4.18	128,434.68	13.45	25,797.10
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	1.50	1,500.00	3.49	107,233.74	8.75	16,782.50
9	William B. Rodgers, Pittsburg, Pa	1.50	1,500.00	4.47	137,345.22	12.90	24,742.20
10	Heldmaier & Neu, Chicago, Ill	.75	750.00	3.30	101,395.80	11.58	22,210.44
11	Joseph Gianini, Pittsburg, Pa	1.75	1,750.00	6.00	184,356.00	10.50	20,139.00
12	I. V. Hoag, jr., Pittsburg, Pa	2.00	2,000.00	4.74	145,641.24	17.00	32,606.00
13	McArthur Bros. Co., Chicago, Ill	2.00	2,000.00	4.30	132,121.80	11.50	22,057.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	1.00	1,000.00	3.00	92,178.00	10.00	19,180.00

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Rubble masonry (504 cubic yards).		Coping masonry (1,077 cubic yards).		Brick masonry (629 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$5.75	$2,898.00	$18.00	$19,386.00	$8.25	$5,189.25
2	C. I. McDonald, Pittsburg, Pa	3.50	1,764.00	18.50	19,924.50	6.75	4,245.75
3	Jolly & Harrold, Beaver Falls, Pa.	4.00	2,016.00	14.00	15,078.00	7.00	4,403.00
6	Western Construction Co., Charleston, W. Va	5.25	2,646.00	16.50	17,770.50	10.44	6,566.76
7	McIlvain, Unkefer Co., Pittsburg, Pa.....	4.88	2,459.52	21.04	22,660.08	10.98	6,906.42
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	4.00	2,016.00	16.50	17,770.50	7.00	4,403.00
9	William B. Rodgers, Pittsburg, Pa.	5.90	2,973.60	16.90	18,201.30	12.90	8,114.10
10	Heldmaier & Neu, Chicago, Ill.....	a 5.70	2,872.80	15.55	16,747.35	9.83	6,183.07
11	Joseph Gianini, Pittsburg, Pa	6.00	3,024.00	15.00	16,155.00	8.00	5,032.00
12	I. V. Hoag, jr., Pittsburg, Pa.....	8.50	4,284.00	19.00	20,463.00	14.00	8,806.00
13	McArthur Bros. Co., Chicago, Ill ..	5.25	2,646.00	17.25	18,578.25	9.50	5,975.50
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	5.40	2,721.60	13.60	14,647.20	8.40	5,283.60

No. of proposal.	Name and address of bidder.	Oak timber in permanent construction (388,550 feet B. M.).		Pine timber in permanent construction (48,600 feet B. M.)		Hemlock timber in permanent construction (246,400 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$32.00	$12,433.60	$32.00	$1,555.20	$18.00	$4,435.20
2	C. I. McDonald, Pittsburg, Pa	27.50	10,685.13	37.50	1,822.50	20.00	4,928.00
3	Jolly & Harrold, Beaver Falls, Pa.	35.00	13,599.25	33.00	1,603.80	22.00	5,420.80
6	Western Construction Co., Charleston, W. Va.....	31.00	12,045.05	32.00	1,555.20	26.00	6,406.40
7	McIlvain, Unkefer Co., Pittsburg, Pa.....	39.04	15,168.99	31.72	1,541.59	10.52	4,809.72
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	30.00	11,656.50	31.00	1,506.60	15.50	3,819.20
9	William B. Rodgers, Pittsburg, Pa.	43.00	16,707.65	45.00	2,187.00	24.50	6,036.80
10	Heldmaier & Neu, Chicago, Ill.....	38.80	15,075.74	35.75	1,737.45	19.10	4,706.24
11	Joseph Gianini, Pittsburg, Pa.....	55.00	21,370.25	55.00	2,673.00	24.00	5,913.60
12	I. V. Hoag, jr., Pittsburg, Pa.....	60.00	23,313.00	50.00	2,430.00	40.00	9,856.00
13	McArthur Bros. Co., Chicago, Ill ..	46.00	17,873.30	32.00	1,555.20	20.00	4,928.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	36.00	13,987.80	36.00	1,749.60	20.00	4,928.00

No. of proposal.	Name and address of bidder.	Gravel or earth filling (53,000 cubic yards).		Framing timber (4,416 linear feet).		Stone filling (2,018 cubic yards).		Cast iron (176,083 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa.....	$0.50	$26,500.00	$0.20	$883.20	$2.00	$4,036.00	$0.08	$5,282.49
2	C. I. McDonald, Pittsburg, Pa.....	.30	15,900.00	.18	794.88	1.75	3,531.50	.026	4,578.18
3	Jolly & Harrold, Beaver Falls, Pa ...	.39	20,670.00	.12	529.92	1.25	2,522.50	.03	5,282.49
6	Western Construction Co., Charleston, W. Va	.40	21,200.00	.20	883.20	.98	1,977.64	.0325	5,722.70
7	McIlvain, Unkefer Co., Pittsburg, Pa..	.33	17,490.00	.18	794.88	2.13	4,298.34	.0325	5,722.70
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.....	.24	12,720.00	.30	1,324.80	2.50	5,045.00	.032	5,634.66
9	William B. Rodgers, Pittsburg, Pa	.59	31,270.00	.29	1,280.64	2.15	4,338.70	.0295	5,194.45
10	Heldmaier & Neu, Chicago, Ill	.35	18,550.00	.35	1,545.60	2.65	5,347.70	.03	5,282.49
11	Joseph Gianini, Pittsburg, Pa	.60	31,800.00	.40	1,766.40	2.50	5,045.00	.025	4,402.08
12	I. V. Hoag, jr., Pittsburg, Pa	.60	31,800.00	.30	1,324.80	2.00	4,036.00	.05	8,804.15
13	McArthur Bros. Co., Chicago, Ill	.28	14,840.00	.25	1,104.00	1.50	3,027.00	.025	4,402.08
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.20	10,600.00	.20	883.20	.96	1,937.28	.0375	6,603.11

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Wrought iron (78,715 pounds).		Structural steel (194,144 pounds).		Bolt holes (1,000 linear feet).		Total amount of bid.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
1	Jutte & Foley Co., Pittsburg, Pa	$0.03	$2,361.45	$0.04	$7,765.76	$0.20	$200.00	$285,301.75
2	C. I. McDonald, Pittsburg, Pa	.0325	2,558.24	.0375	7,280.40	.30	300.00	234,072.16
3	Jolly & Harrold, Beaver Falls, Pa	.035	2,755.02	.04	7,765.76	.40	400.00	315,415.44
6	Western Construction Co., Charleston, W. Va	.0325	2,558.24	.0325	6,309.68	.20	200.00	287,233.47
7	McIlvain, Unkefer Co., Pittsburg, Pa	.04	3,148.60	.04	7,765.76	.25	250.00	312,044.98
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	.032	2,518.88	.032	6,212.61	.25	250.00	236,963.11
9	William B. Rodgers, Pittsburg, Pa	.0395	3,109.24	.0495	9,610.13	.39	390.00	315,958.49
10	Heldmaier & Neu, Chicago, Ill	.03	2,361.45	.07	15,590.08	.50	500.00	260,353.47
11	Joseph Gianini, Pittsburg, Pa	.025	1,967.88	.035	6,795.04	.50	500.00	350,736.85
12	I. V. Hoag, jr., Pittsburg, Pa	.05	3,935.75	.05	9,707.20	.50	500.00	376,113.14
13	McArthur Bros. Co., Chicago, Ill	.04	3,148.60	.035	6,795.04	.25	250.00	280,369.77
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.0375	2,951.81	.0375	7,280.40	.28	280.00	206,509.60

a Price on duplicate proposal, $5.75.

Recommended for award to No. 2, C. I. McDonald.

LOCK NO. 5.

No. of proposal.	Name and address of bidder.	Cofferdam (1,500 linear feet).		Piling (6,118 linear feet).		Common excavation (53,084 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa.	$10.00	$15,000.00	$0.30	$1,835.40	$0.50	$26,542.00
2	C. I. McDonald, Pittsburg, Pa.	10.00	15,000.00	.30	1,835.40	.37½	19,906.50
3	Jolly & Harrold, Beaver Falls, Pa.	15.00	22,500.00	.30	1,835.40	.75	39,813.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	18.53	27,795.00	.63	3,854.34	.56	29,727.04
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	9.30	13,950.00	.40	2,447.20	.38	20,171.92
9	William B. Rodgers, Pittsburg, Pa.	9.87	14,805.00	.35	2,141.30	.49	26,011.16
10	Heldmaier & Neu, Chicago, Ill	12.00	18,000.00	.37	2,263.66	.40	21,233.60
11	Joseph Gianini, Pittsburg, Pa	2.50	3,750.00	.40	2,447.20	.65	34,504.60
12	I. V. Hoag, jr., Pittsburg, Pa	18.00	27,000.00	.40	2,447.20	.70	37,158.80
13	McArthur Bros. Co., Chicago, Ill.	12.00	18,000.00	.32	1,957.76	.35	18,579.40
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	7.00	10,500.00	.30	1,835.40	.15	7,962.60

No. of proposal.	Name and address of bidder.	Excavation in rock (1,000 cubic yards).		Concrete masonry (30,726 cubic yards).		Ashlar masonry (1,918 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa.	$5.00	$5,000.00	$3.90	$119,831.40	$12.60	$24,166.80
2	C. I. McDonald, Pittsburg, Pa	3.00	3,000.00	3.50	107,541.00	10.50	20,139.00
3	Jolly & Harrold, Beaver Falls, Pa.	2.00	2,000.00	5.50	168,993.00	10.00	19,180.00
7	McIlvain, Unkefer Co., Pittsburg, Pa	.75	750.00	4.00	122,904.00	12.95	24,838.10
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y	1.50	1,500.00	3.49	107,233.74	8.75	16,782.50
9	William B. Rodgers, Pittsburg, Pa.	1.50	1,500.00	4.47	137,345.22	12.90	24,742.20
10	Heldmaier & Neu, Chicago, Ill	.75	750.00	3.30	101,395.80	10.38	19,908.84
11	Joseph Gianini, Pittsburg, Pa	1.75	1,750.00	6.10	187,428.60	11.50	22,057.00
12	I. V. Hoag, jr., Pittsburg, Pa	2.00	2,000.00	4.74	145,641.24	17.00	32,606.00
13	McArthur Bros. Co., Chicago, Ill.	2.00	2,000.00	4.25	130,585.50	11.25	21,577.50
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	1.00	1,000.00	3.00	92,178.00	10.00	19,180.00

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Rubble masonry (504 cubic yards).		Coping masonry (1,077 cubic yards).		Brick masonry (629 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$5.75	$2,898.00	$18.00	$19,386.00	$8.25	$5,189.25
2	C. I. McDonald, Pittsburg, Pa	3.60	1,814.40	18.50	19,924.50	6.60	4,151.40
3	Jolly & Harrold, Beaver Falls, Pa.	4.00	2,016.00	14.00	15,078.00	7.00	4,403.00
7	McIlvain, Unkefer Co., Pittsburg, Pa.....	4.68	2,358.72	20.18	21,733.86	10.53	6,623.37
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.....	4.00	2,016.00	16.50	17,770.50	7.00	4,403.00
9	William B. Rodgers, Pittsburg, Pa.	5.90	2,973.60	16.90	18,201.30	12.90	8,114.10
10	Heldmaier & Neu, Chicago, Ill.....	5.20	2,620.80	14.45	15,562.65	9.83	6,183.07
11	Joseph Gianini, Pittsburg, Pa.....	6.25	3,150.00	15.50	16,693.50	8.20	5,157.80
12	I. V. Hoag, jr., Pittsburg, Pa.....	8.50	4,284.00	19.00	20,463.00	14.00	8,806.00
13	McArthur Bros. Co., Chicago, Ill ..	5.25	2,646.00	17.25	18,578.25	9.50	5,975.50
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	5.40	2,721.60	13.60	14,647.20	8.40	5,283.60

No. of proposal.	Name and address of bidder.	Oak timber in permanent construction (388,550 feet B. M.).		Pine timber in permanent construction (48,600 feet B. M.).		Hemlock timber in permanent construction (246,400 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa..	$32.00	$12,433.60	$32.00	$1,555.20	$18.00	$4,435.20
2	C. I. McDonald, Pittsburg, Pa.....	27.50	10,685.13	37.50	1,822.50	20.00	4,928.00
3	Jolly & Harrold, Beaver Falls, Pa.	35.00	13,599.25	33.00	1,603.80	22.00	5,420.80
7	McIlvain, Unkefer Co., Pittsburg, Pa.....	37.44	14,547.31	30.42	1,478.41	18.72	4,612.60
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.....	30.00	11,656.50	31.00	1,506.60	15.50	3,819.20
9	William B. Rodgers, Pittsburg, Pa.	43.00	16,707.65	45.00	2,187.00	24.50	6,036.80
10	Heldmaier & Neu, Chicago, Ill.....	38.80	15,075.74	35.75	1,737.45	19.10	4,706.24
11	Joseph Gianini, Pittsburg, Pa.....	60.00	23,313.00	60.00	2,916.00	26.00	6,406.40
12	I. V. Hoag, jr., Pittsburg, Pa.....	60.00	23,313.00	50.00	2,430.00	40.00	9,856.00
13	McArthur Bros. Co., Chicago, Ill ..	46.00	17,873.30	32.00	1,555.20	20.00	4,928.00
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind.....	36.00	13,987.80	36.00	1,749.60	20.00	4,928.00

No. of proposal.	Name and address of bidder.	Gravel or earth filling (53,000 cubic yards).		Framing timber (4,416 linear feet).		Stone filling (2,018 cubic yards).		Cast iron (176,083 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.
1	Jutte & Foley Co., Pittsburg, Pa.....	$0.50	$26,500.00	$0.20	$883.20	$2.00	$4,036.00	$0.03	$5,282.49
2	C. I. McDonald, Pittsburg, Pa.....	.33⅓	17,666.67	.18	794.88	1.75	3,531.50	.02½	4,578.16
3	Jolly & Harrold, Beaver Falls, Pa	.35	18,550.00	.12	529.92	1.00	2,018.00	.03	5,282.49
7	McIlvain, Unkefer Co., Pittsburg, Pa.....	.32	16,960.00	.18	794.88	2.05	4,136.90	.032	5,634.66
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.	.24	12,720.00	.30	1,324.80	2.50	5,045.00	.032	5,634.66
9	William B. Rodgers, Pittsburg, Pa.....	.59	31,270.00	.29	1,280.64	2.15	4,338.70	.0295	5,194.45
10	Heldmaier & Neu, Chicago, Ill	.35	18,550.00	.35	1,545.60	2.55	5,145.90	.03	5,282.49
11	Joseph Gianini, Pittsburg, Pa.....	.65	34,450.00	.40	1,766.40	2.50	5,045.00	.025	4,402.08
12	I. V. Hoag, jr., Pittsburg, Pa.....	.60	31,800.00	.30	1,324.80	2.50	5,045.00	.05	8,804.15
13	McArthur Bros. Co., Chicago, Ill	.90	15,900.00	.25	1,104.00	1.25	2,522.50	.025	4,402.08
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.20	10,600.00	.20	883.20	.96	1,937.28	.0375	6,603.11

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Abstract of proposals for constructing Locks Nos. 2, 3, 4, and 5, Ohio River, etc.—Cont'd.

No. of proposal.	Name and address of bidder.	Wrought iron (78,715 pounds).		Structural steel (194,144 pounds).		Bolt holes (1,000 linear feet).		Total.
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
1	Jutte & Foley Co., Pittsburg, Pa	$0.03	$2,361.45	$0.04	$7,765.76	$0.20	$200.00	$285,301.75
2	C. I. McDonald, Pittsburg, Pa	.03½	2,558.24	.03¾	7,280.40	.30	300.00	247,457.68
3	Jolly & Harrold, Beaver Falls, Pa	.035	2,755.02	.04	7,765.76	.40	400.00	333,743.44
7	McIlvain, Unkefer Co., Pittsburg, Pa	.038	2,991.17	.038	7,377.47	.23	230.00	299,347.83
8	Wm. E. Hingston, F. M. Sylvester, Buffalo, N. Y.	.032	2,518.88	.032	6,212.61	.25	250.00	236,963.11
9	William B. Rodgers, Pittsburg, Pa	.0395	3,109.24	.0495	9,610.13	.39	390.00	315,958.49
10	Heldmaier & Neu, Chicago, Ill	.03	2,361.45	.07	13,590.08	.50	500.00	256,413.37
11	Joseph Gianini, Pittsburg, Pa	.025	1,967.88	.035	6,795.04	.50	500.00	364,500.50
12	I. V. Hoag, jr., Pittsburg, Pa	.05	3,935.75	.05	9,707.20	.50	500.00	377,122.14
13	McArthur Bros. Co., Chicago, Ill	.04	3,148.60	.035	6,795.04	.25	250.00	278,378.63
14	Eigenmann & Hollerbach, Eichel & Arnold, Evansville, Ind	.0375	2,951.81	.0375	7,280.40	.28	280.00	206,509.60

Recommended for award to No. 8, Hingston & Sylvester.

Appropriation, improving Ohio River below Pittsburg, Pa. Balance of appropriation available for payments under proposed contracts: Locks Nos. 2, 3, 4, and 5, act of June 3, 1896, $10,000, less engineering expenses; Locks Nos. 2, 3, and 4, act of June 4, 1897, $400,000, less engineering expenses.

Abstract of contracts for improving Ohio River below Pittsburg, Pa., in force during the fiscal year ending June 30, 1898.

Contractor.	Nature of contract.	Date.	To expire.
		1897.	1898.
Eigenmann & Hollerbach and Eichel & Arnold.	Constructing lock No. 2	Dec. 7	Dec. 1
Do	Constructing lock No. 3	Dec. 27	Dec. 1
Do	Constructing lock No. 4	Dec. 7	Dec. 1
Do	Constructing lock No. 5	Dec. 27	Dec. 1
			1897.
Hulings Bros	Constructing Chanoine Dam and masonry pier, No. 6.	Mar. 19	a Dec. 1

a Extended to August 1, 1898.

REPORT OF MR. WILLIAM MARTIN, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bellevue, Pa., June 30, 1898.

MAJOR: I have the honor to submit the following report on movable dams, Ohio River, for the fiscal year ending June 30, 1898:

Dam No. 6.—Work on this dam, contract with Hulings Bros., Pittsburg, Pa., entered into March 19, 1897, for the construction of 600 feet of Chanoine Dam and a stone masonry pier, was under way at the beginning of the fiscal year. The cofferdam, which was projected to embrace the entire width of the Chanoine Dam and the pier, was curtailed 125 feet by orders of the Chief of Engineers, dated June 30, 1897. The work was carried on in accordance with this change. The piling on the upper

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arm of the cofferdam had been driven to the outside limit, and a timber crib at the outer corner, filled with stone, built. The piling was taken out and the crib removed and rebuilt 125 feet to the right, thus giving that much more channel space.

Previous to closing up the cofferdam inclosure a dredge was put to work on the site of the foundation, making the excavation therefor and dredging down to nearly the required depth; the dredge was removed from the inclosure and the cofferdam completed. The pumps were started August 15, but the progress of unwatering the inclosure was slow on account of numerous leaks in the cofferdam; these were finally stopped sufficiently to admit of pumping out the inclosure, when excavation for the foundation was begun. As soon as the excavation was sufficiently advanced, the pile driving for the grillage below the foundation of the dam was commenced. This work progressed intermittently, having to stop frequently for piling. The piling for the grillage was completed for a distance of 425 feet.

When the required depth of excavation was reached in the foundation for the dam a loose gravel was found, which was considered unsafe to build on, and it was accordingly decided to drive sheet piling to a depth of 15 feet below the bottom reference of the concrete foundation. White-oak sawed piling, 6 inches by 12 inches by 15 feet, was driven at the upper side of the foundation. When the sheet piling was far enough advanced the concrete work was begun, October 7, and followed the pile driving closely. The concrete was built up to a reference of 4.25 feet below the sill level, which is 0.5 foot below the timber framework, and at this reference the concrete was finished to a length of 336 feet. The anchor bolts were set a corresponding distance to the concrete. A few of the foundation timbers were put in place, but none were permanently set.

On the evening of November 16 a rise in the river flooded the cofferdam inclosure, when the contractors discontinued any efforts toward prosecuting the work.

In accordance with paragraph 106 of the contract, the United States then took up the work and attempted to complete it, but fall rains and high water prevailed, and no permanent work could be accomplished. During the winter floods 300 feet of the outer arm of the cofferdam was destroyed, necessitating its rebuilding before the permanent work can be resumed. This has now been done, and the operating plant is being erected preparatory to unwatering the inclosure.

I would refrain from any comments on the manner in which the contractors managed their work. With a most favorable and long season of low water, they completed only about one-quarter of their contract, when with ordinary business attention and diligence, their entire work of the contract could have been finished.

As the spring advanced and the contractors showed no sign of commencing work, preparations were begun to resume same, the performance of which it is believed will have to be done by the United States by hired labor, independent of anything the contractors may do. Work was begun in April building wickets, the timber for which was purchased last fall after the contractors ceased operations, 125 of which were completed. There was also purchased with the wicket timber a large lot of foundation timber, which has been framed ready for assembling as soon as the foundation is ready.

During the winter and spring floods 320 linear feet of the cofferdam was carried away. Work of rebuilding the destroyed portion was begun early in June, and completed during the month. All preparatory work of putting operating machinery in condition ready for operation has been performed.

The upper and lower guiding walls of the lock remained partly uncompleted. The timber facing could not be finished on the lower level of the walls for a height of 5 feet on account of the high stage of water. An agreement was made with W. B. Rodgers for the completion of these walls, consisting of the timber facing, a small amount of concrete work, and a flight of stone steps on the lower wall leading from the higher to the lower level. The work was begun and entirely finished during the month of October, 1897.

The entrances to the lock, particularly the upper one, were very shoal. An agreement was made with W. B. Rodgers to dredge these approaches and deposit the dredged material in the guiding wall inclosures. This work was begun July 1, and continued until December, when the stage of water became too high to continue the work. Some additional dredging will be required to complete the necessary work in order to make the entrances to the lock easy of access.

* * * * * * * *

Dams 2 to 5.—The locks are under contract with Messrs. Eigenmann & Hollerbach and Eichel & Arnold, of Evansville, Ind., entered into December 7 and 27, 1897. The title to the sites of Locks and Dams Nos. 3 and 5 is not yet complete, and in consequence no work has been begun on them. The title to the sites for Locks and Dams Nos. 2 and 4 is vested in the United States, and work on these two has been commenced.

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Lock No. 2.—Work was begun by the contractor about the middle of April, by the erection of a temporary building for a shop and other purposes. Materials for plant, engines, pumps, boilers, and miscellaneous machinery have been delivered on the ground. The cofferdam was started on the upper wing by driving a line of piling. After a few piling were driven it was discovered that a hard stratum lay beneath the river bed, and after a closer investigation by boring it was found that a solid bed of rock underlay the site of the lock. The pile driving was consequently discontinued. While no borings were originally made to determine the underlying material, it was confidently believed that no rock existed at this site. It was a great surprise to find rock at the only site where it was not expected.

The framework of the cofferdam was set up to the outer upper corner, but no gravel filling was put in; the structure in this condition, having no stability, collapsed with a slight rise in the river. It has been rebuilt.

On June 11 an agreement was made with B. A. Groah, of Bellevue, Pa., for the erection of a temporary building at this dam for use as an office during construction, at $457, complete.

Lock No. 4.—The river bed was found to be composed of gravel, and no obstruction to pile driving was encountered at a depth of 12 to 14 feet. Work was begun by the contractor by driving a line of piling upstream from the outer upper corner of the cofferdam inland, at an angle of 45 degrees with the current, for a protecting guard to the cofferdam, the tops of which were bound together by waling strips. The framework of the cofferdam was set up in a similar manner to that at Lock No. 2, and the inclosure filled with gravel.

On June 11 an agreement was made with B. A. Groah, of Bellevue, Pa., for the erection of a temporary building at this dam for use as an office during construction, at $482, complete.

Respectfully submitted.

WILLIAM MARTIN, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 5.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for this work:

Act of August 11, 1888	$102,000

At the beginning of the year the only unfinished work on this improvement was the construction of a lock house at the ice harbor at mouth of Muskingum, and cleaning up the grounds at site of same, for which the river and harbor act of August 17, 1894, had provided the necessary funds from the balance remaining to the credit of this appropriation. (See Annual Report, 1896, part 4, pp. 2103–2105.) Nothing was done during the year, awaiting the acquisition of land, whose grant is now under consideration by the State legislature.

Commercial statistics relating to the Muskingum are appended to the report on operating and care of the locks and dams.

The work is under the supervision of Mr. Edmund Moeser, resident engineer, whose report is appended.

Money statement.

July 1, 1897, balance unexpended	$5,620.43
June 30, 1898, amount expended during fiscal year	54.19
July 1, 1898, balance unexpended	5,566.24
July 1, 1898, outstanding liabilities	2.25
July 1, 1898, balance available	5,563.99

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REPORT OF MR. EDMUND MOESER, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, June 30, 1898.

MAJOR: I have the honor to submit the following annual report for the fiscal year ending June 30, 1898, upon operations for improving Muskingum River, Ohio:

At the beginning of the year the only unfinished work on this improvement was the building of a dwelling for the lockmaster and the renovation of the grounds about the ice harbor lock at mouth of Muskingum, for which the river and harbor act of August 17, 1894, had provided the necessary funds from the balance remaining to the credit of this appropriation. This work has been again postponed, awaiting the acquisition by the United States of the required land at Marietta, Ohio, which is still pending.

During the year plans and a description of the land desired for lock-house purposes have been prepared and submitted.

Respectfully submitted.

EDMUND MOESER, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 6.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

A statement of the extent, original cost, etc., of the works embraced under this title is given in the Annual Report of the Chief of Engineers for 1895, part 1, page 322.

Navigation was interrupted at the 10 locks for nine days in December and January by ice closing the river, and for five days in March by high water. Lock No. 1 was closed fifteen days in September for repairs, but this did not interfere with navigation, as low water in the Ohio made the lock practically inaccessible. At the close of the year all the locks were in good order.

During March there occurred a phenomenal flood, the water reaching a height of 31.7 feet above normal pool level at Zanesville—2.8 feet higher than the flood of 1884. Beyond the washing of canal banks and embankments at abutments, etc., and large deposits of mud and drift little damage was done.

Lock and Dam No. 1.—The repair of lock floor, as estimated for, was not completed, owing to inability, with means at hand, to pump out the lock. The cavities under the broken floor were filled with gravel and concrete, tight material placed around lock walls, and timber bulkheads placed across the outside of all filling culverts in walls. A protection crib was built from head of river wall. All disintegrated stone in chamber faces and miter-sill wall was dressed back and cavities filled with concrete. The partial repair thus made appears sufficient for the present. The middle gates were rebuilt and the old lock house repaired. Other minor repairs were made.

Lock and Dam No. 2.—Rebuilt 36 feet of crest of dam and 101 feet of lower apron, and filled all empty spaces with stone. Four decayed lock-gate arms were replaced. Damages to storehouse and lock house caused by flood were repaired.

Lock and Dam No. 3.—Repairs were made to first and second steps and lower apron of dam by resheeting, refilling, and replacing some longitudinal timbers. Such work as was required to keep the plant in good condition was done.

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Lock and Dam No. 4.—The spill dam, which is only occasionally submerged, causing rapid decay of timbers in the structure, was repaired by replacing the exposed timber steps on front by a concrete slope wall. The usual repairs caused by wear and tear were made, two washouts in embankment refilled, and 100 feet of fence replaced.

Lock and Dam No. 5.—The joints of lock walls were repointed, and cavities filled with concrete. Lower apron of dam was rebuilt for 147 feet. Other needed repairs were made.

Lock and Dam No. 6.—The damage done by the flood was repaired. It was small.

Lock and Dam No. 7.—The old wooden drawbridge across canal was replaced with a plate girder bridge, the substructure having been repaired and modified. The bank below right abutment of dam was protected by an earth fill and crib extension. Repairs were made to the dam by refilling and resheeting a part of lower apron and rebuilding 60 feet of front wall. Some repairs were necessary after the flood, which were made, as were also others of a minor character.

Lock and Dam No. 8.—The right abutment of dam was repaired by relaying some masonry, and protected by a crib extension and fill. An extraordinary deposit was left in the lock chamber by the flood, which required six days of uninterrupted labor to remove. Minor repairs were made.

Lock and Dam No. 9.—Repairs were made to the dam; replaced longitudinal timbers and resheeted 55 feet of lower apron. The storehouse, waiting room, lock gates, and irons were repainted, and minor repairs made.

The old lateral canal, no longer required by navigation, but necessarily maintained to supply the mill with water power, was damaged during the flood by washing of banks. These places have been repaired.

Lock and Dam No. 10.—The old step dam was replaced for 220 feet by a slope and several empty cribs were refilled with stone. Repairs were made to walls of lock, operating machines, and lock irons. The guide crib below land wall of lock was rebuilt and the damaged stone revetment above replaced with concrete. Waiting room, storehouse, and lock gates were repainted.

Good service has been rendered by the U. S. dredge *Malta* and U. S. towboat *Vega*. Repairs were made to both boats.

During the March flood the draw of the Beverly-Waterford Bridge was carried off its piers and lodged in the river (the wreck has not been removed), and the abutment on shore side of draw space of the Taylorsville Bridge fell into the channel. Immediate steps were taken for its removal.

This work was under the efficient care of Mr. Edmund Moeser, resident engineer, whose report, giving details of the work, is hereto appended.

The following is a statement of the amounts and dates of all appropriations and allotments for this work:

August 5, 1886 (appropriated)	$20,000.00	December 9, 1891 (allotted)	$1,200.00
July 21, 1887 (allotted)	190,000.00	January 5, 1892 (allotted)	12,241.54
August 13, 1888 (allotted)	177,623.00	August 3, 1892 (allotted)	42,919.47
July 1, 1889 (allotted)	232,080.00	July 22, 1893 (allotted)	52,745.36
July 19, 1890 (allotted)	195,665.00	July 25, 1894 (allotted)	47,157.66
May 28, 1891 (allotted)	20,000.00	July 12, 1895 (allotted)	29,971.20
July 8, 1891 (allotted)	155,200.00	July 24, 1896 (allotted)	41,337.10
November 9, 1891 (allotted)	39,980.00	July 23, 1897 (allotted)	43,527.50
November 24, 1891 (allotted)	1,200.00	Total	1,302,847.83

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Special work authorized by act of Congress.

March 21, 1895 (allotted), protection wall at Zanesville	$1,651.00
June 17, 1895 (allotted), pier of railroad bridge at Marietta	10,449.60
June 17, 1895 (allotted), pier of county bridge at Taylorsville	5,834.20
Total	17,934.80

Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, for the fiscal year ending June 30, 1898, to wit:

No. of voucher.	To whom paid.	For what paid.	Amount.
	July, 1897.		
1	Pay roll	Service	$645.00
2	.....do	.....do	481.90
3	.....do	.....do	345.00
4	.....do	.....do	301.90
5	.....do	.....do	228.96
6	.....do	.....do	80.46
7	.....do	.....do	56.88
8	.....do	.....do	31.86
9	.....do	.....do	15.48
10	.....do	.....do	14.94
11	.....do	.....do	8.16
12	.....do	.....do	5.50
13	J. Seyler & Bro	Ruby globes	1.02
14	T. S. Menough	Repairing typewriting machine	2.50
15	G. A. Stanfield & Co	Material and services	50.50
16	The Zanesville Hardware Co	Rope, belting, etc	26.49
17	W. P. Scott	Duck, etc	1.27
18	Griffith & Wedge Co	Pocket wheels, services, etc	33.36
19	J. F. Fouts	Riprap stone	303.68
20	Claude Wilson	Services with team	2.28
21	Wm. Northrup	Riprap stone	330.69
22	The Marietta Manufacturing Co	Services and material	5.72
23	Standard Oil Co	Oil	4.04
24	.....do	.....do	4.24
25	Edmund Moeser	Traveling expenses	19.50
26	W. B. Cosgrave	White oak timber	391.69
27	Joseph Garrett	Coal	104.00
28	Central Union Telephone Co	Toll on messages	2.60
29	.... do	Hire of instruments	14.25
30	M. Luby	Rent of office	41.66
31	Steamer Hazel Rice	Services	552.00
37	City of Marietta, Ohio	Water permit	1.00
189	Philip Spaulding	Rubblestone	280.00
	August, 1897.		
4	Pay roll	Service	645.00
5	.....do	.....do	516.04
6	.....do	.....do	345.00
7	.....do	.....do	314.90
8	.....do	.....do	22.20
9	.....do	.....do	9.36
44	George Lilienthal	Letter paper	4.25
45	Joseph Garrett	Coal	20.00
46	The Zanesville Hardware Co	Soap, kettle, bolts, etc	4.17
48	Steamer Hazel Rice	Services	621.00
67	Griffith & Wedge Co	Bolts, nails, etc	3.99
71	Crumbaker & Co	Dynamite	2.25
72	The Blandy Machine Co	Hog chains, cast studs, etc	26.30
73	.....do	Pipe lining, boiler tubes, etc	95.71
75	The C. F. Bradley Co	Cyclostyle ink	.50
	September, 1897.		
4	Pay roll	Service	645.00
5	.....do	.....do	486.18
6	.....do	.....do	3.78
7	.....do	.....do	73.82
8	.....do	.....do	81.90
9	.....do	.....do	14.40
10	.....do	.....do	100.80
11	.....do	.....do	312.50
12	.....do	.....do	524.32
13	.....do	.....do	345.00
18	.....do	.....do	245.18

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	September, 1897—Continued.		
19	Pay roll	Service	$22.14
20	....do	....do	55.08
25	....do	....do	16.20
30	The Argand Refining Co	Grease, oil, and waste	71.71
31	M. Lanz & Sons	Drift bolts	253.27
32	The G. Mylius Co	Chairs, seats, and cloth	10.25
35	W. S. Coulson	Varnish	.60
36	Atlas Cement Co	Cement	1,140.00
37	The Zanesville Hardware Co	Hardware, etc	27.79
66	The Marietta Manufacturing Co	Services	1.20
67	Harry L. Fillmore	Saw	2.00
68	Raleigh Wilson	Services with team	9.12
72	Perley Wallace	Coal	39.10
73	S. A. Jenkins	Stationery	3.60
76	M. Luby	Rent of office	41.66
78	Steamer Hazel Rice	Services	598.00
81	H. H. Sturtevant & Co	Towels	7.20
83	Zanesville post office	Rent of post-office drawer	.75
118	The C. F. Bradley Co	Letter-copying books	4.00
127	W. H. Heuer	Mileage	16.48
172	Joseph Garrett	Coal	14.60
206	T. S. Menough	Paper, typewriter ribbons, etc	2.75
209	Geo. Strecker & Co	Smokestack	14.00
210	Geo. T. Elston	Boat poles and lumber	13.20
211	J. Seyler & Bro	Roofing-paper, nails, etc	20.80
213	John C. Duerr	Services and iron	10.64
214	John Wilking	Services	11.63
215	Griffith & Wedge Co	Ash pan and bolt	3.86
217	Curtis & Co	Lumber	2.23
218	George Lilienthal	Writing paper	1.25
219	....do	Paper	.50
221	Seright & Webster	Services and material	1.05
223	H. Warren	Oil	.20
275	The Zanesville Hardware Co	Cotton duck, etc	52.10
319	Standard Oil Co	Oil	16.40
326	Geo. T. Elston	Planking	39.60
327	Geo. Strecker & Co	Services and material	17.25
328	John H. Becker	Lumber, slate, etc	128.83
332	W. P. Scott	Nails	1.60
335	Perley Wallace	Coal	57.40
337	W. H. Styer	Oil and paint	1.40
	October, 1897.		
9	Pay roll	Service	645.00
10	....do	....do	939.42
11	....do	....do	26.64
12	....do	....do	1,003.37
13	....do	....do	345.00
14	....do	....do	314.90
15	....do	....do	526.48
16	....do	....do	124.65
17	....do	....do	10.98
18	....do	....do	13.50
19	....do	....do	120.38
20	....do	....do	240.76
21	....do	....do	7.02
22	....do	....do	18.18
23	....do	....do	171.38
28	....do	....do	2.52
50	Edmund Moeser	Traveling expenses	47.10
54	J. Seyler & Bro	Lime, powder, bolts, etc	1.69
55	Perley Wallace	Coal	3.20
56	Steamer Hazel Rice	Services	621.00
57	The Marietta Manufacturing Co	Pipe connections, services, etc	73.13
58	....do	Services, steel, etc	2.00
59	Judd Longley	Services with team	.60
60	Henry Spies	....do	1.80
61	Western Union Telegraph Co	Telegrams	1.26
62	Geo. T. Elston	Pine timber	14.00
63	W. B. Cosgrave	White oak lumber	73.85
11	Wm. B. Ladue	Mileage	14.96
13	Steamer Burnadina King	Freight	1.25
52	John W. Cochrel	Services	1.00
61	Raleigh Wilson	Services with team	1.14
64	Zanesville post-office	Rent of post-office drawer	.75
72	J. Seyler & Bro	Hardware	18.32
81	The Marietta Manufacturing Co	Lumber, etc	3.56
83	The Zanesville Hardware Co	Ax handles and augers	2.10

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	October, 1897—Continued.		
84	James B. Hartsell	Services with team	$0.88
86	J. Drucker	Ribbon	.15
92	J. T. Lansley	Soap, brooms, mops, etc	10.50
93	Griffith & Wedge Co	Pocket wheels, bolts, etc	44.84
94	Perley Wallace	Coal	16.00
95	John C. Duerr	Services, etc	7.90
96	S. D. Davis	Hire of barge	10.00
97	Central Union Telephone Co	Toll on messages	5.70
118	Joseph Garrett	Coal	14.00
119	John Wilking	Services of teamster with teams	4.88
127	The Postal Telegraph Cable Co	Telegrams	.40
141	F. P. Bailey & Co	Oil	.80
142	John Hopp	Services	5.60
144	Central Union Telephone Co	Hire of instruments	14.25
187	S. A. Jenkins	Pay envelopes	.75
188	J. F. Fouts	Stone	213.58
	November, 1897.		
15	Pay roll	Service	645.00
16	.....do	.....do	465.39
17	.....do	.....do	64.08
18	.....do	.....do	13.68
19	.....do	.....do	67.32
20	.....do	.....do	288.54
21	.....do	.....do	204.48
22	.....do	.....do	57.82
23	.....do	.....do	24.18
24	.....do	.....do	354.74
25	.....do	.....do	21.24
26	.....do	.....do	250.74
27	.....do	.....do	314.90
28	.....do	.....do	9.66
29	.....do	.....do	525.52
30	.....do	.....do	345.00
52	Wesley Dutro	White oak timber	263.65
53	Joseph Garrett	Coal	11.00
55	The Western Union Telegraph Co	Telegrams	.20
62	The Zanesville Hardware Co	Soap, nails, etc	5.15
63	Griffith & Wedge Co	Coal	.80
64	Curtis & Co	Lumber	2.33
67	M. Lanz & Sons	Drift bolts	84.09
68	Edmund Moeser	Traveling expenses	4.95
72	John C. Duerr	Services	1.10
73	John Wilking	Services of teamster with team	1.13
74	Perley Wallace	Coal	4.40
75	T. Roll	Services with team	1.50
76	The Zanesville Gaslight Co	Gas	1.00
107	City of Zanesville, Ohio	Water rent	6.30
108	J. Blankenbuhler	Ice	11.31
109	The Zanesville Hardware Co	Iron, bolts, etc	3.73
110	Perley Wallace	Coal	3.20
111	W. P. Scott	Files	.80
112	Zanesville Stamp and Stencil Co	Rubber stamps	1.50
113	Perley Wallace	Coal	3.60
122	Bert Patterson	Services with team	3.04
123	Thomas Winstanley	.....do	1.90
124	J. Seyler & Bro	Steel, services, etc	1.11
133	John H. Wheeler	Services	.69
134	Standard Oil Co	Oil	4.16
135	Raleigh Wilson	Services with team	6.46
136	Geo. T. Elston	Lumber	9.36
140	Riecker Bros. Co	Padlocks, bucket, etc	.60
141	John C. Duerr	Services	1.60
142	John Wilking	Services of teamster with team	5.63
144	Perley Wallace	Coal	4.40
145	Steamer Jewel	Freight	.75
146	Mary E. Adams	Paper and services	6.96
147	Promise Rowland	White oak timber	1,069.82
173	Steamer Hazel Rice	Services	598.00
180	The Marietta Manufacturing Co	Bolts, services, etc	15.40
183	Edmund Moeser	Traveling expenses	11.20
185	The Marietta Manufacturing Co	Nuts, iron, and services	1.50
200	John E. Arndt	Hire of barge	70.00
202	Joseph Garrett	Coal	37.00
203	M. Luby	Rent of office	41.66
211	D. P. Price	Stone	303.50
213	The Zanesville Hardware Co	Bolts, nails, etc	4.78

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	December, 1897.		
5	Pay roll	Service	$8.64
6	.....do	.....do	108.18
7	.....do	.....do	56.52
8	.....do	.....do	43.74
9	.....do	.....do	138.84
10	.....do	.....do	12.78
11	.....do	.....do	525.04
12	.....do	.....do	312.50
13	.....do	.....do	645.00
14	.....do	.....do	345.00
15	.....do	.....do	266.85
86	Perley Wallace	Coal	6.30
90	J. W. Leake	Stone	52.80
92	Bauer Brothers	Repairing tapeline	.20
94	Steamer Jewel	Freight	.75
100	Griffith & Wedge Co	Pocket wheels	16.94
102	Standard Oil Co	Oil	8.40
107	The Zanesville Hardware Co	Nails, lantern globes, etc	6.46
112	Henry Roekel	Valves, etc	1.50
116	John Hopp	Services	1.20
118	Coleman & Longabore	White oak timber	110.76
140	Chas. U. Shryock	Stationery	13.80
144	John Wilking	Services with team	8.75
145	Edmund Moeser	Traveling expenses	5.45
146	J. Seyler & Bro	Eave trough, pipe, etc	11.50
150	Perley Wallace	Coal	4.40
153	T. S. Menough	Typewriter ribbon	.75
155	Wm. Ridgely	Services with team	2.66
156	L. N. Rech	.....do	1.52
157	Raleigh Wilson	.....do	7.98
159	Joseph Garrett	Coal	43.00
161	John C. Duerr	Services	1.70
162	Steamer Hazel Rice	.....do	598.00
163	Griffith & Wedge Co	Ironwork, etc	10.98
164	J. W. Severance	Services with team	6.00
166	J. F. Fouts	Stone	281.78
169	Baltimore and Ohio Southwestern Railway Co.	Transportation	4.95
204	The C. F. Bradley Co	Stationery, etc	.90
	January, 1898.		
7	Pay roll	Service	345.00
8	.....do	.....do	620.00
9	.....do	.....do	306.45
10	.....do	.....do	5.04
11	.....do	.....do	2.88
12	.....do	.....do	12.96
13	.....do	.....do	7.20
14	.....do	.....do	222.36
15	.....do	.....do	484.02
27	Steamer Hazel Rice	Services	437.00
43	Central Union Telephone Co	Toll on messages	5.65
48	Adams Express Co	Freight	.50
50	The Zanesville Hardware Co	Oakum, soap, nails, etc	24.38
51	M. V. B. Kennedy	Stationery	18.55
52	John C. Duerr	Services	1.20
53	Joseph Garrett	Coal	52.00
54	John W. Cochrel	Services	1.00
55	Standard Oil Co	Oil	4.00
56	Times Recorder Co	Letter paper	15.40
77	The J. Downerd & Son Co	Coal	6.75
78	United States Express Co	Freight	.25
79	Griffith & Wedge Co	Steel plates, services, etc	19.10
90	Edmund Moeser	Traveling expenses	7.20
95	Central Union Telephone Co	Hire of instruments	14.25
111	M. Luby	Rent of office	41.66
114	John A. Leggett	Services	3.33
118	Zanesville post-office	Rent of P. O. drawer	.75
119	Edmund Moeser	Traveling expenses	2.65
130	Wm. H. Bixby	Mileage	9.70
141	Baltimore and Ohio Southwestern Railway Co.	Transportation	10.35
	February, 1898.		
1	Pay roll	Service	645.00
2	.....do	.....do	345.00
3	.....do	.....do	00.00
4	.....do	.....do	4.32
5	.....do	.....do	19.44

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	February, 1898—Continued.		
6	Pay roll	Service	$7.74
7	.....do	.....do	3.78
8	.....do	.....do	12.96
9	.....do	.....do	172.50
16	.....do	.....do	80.24
19	Baltimore and Ohio Railroad Co	Transportation	4.95
21	Baltimore and Ohio Southwestern Railway Co	.....do	5.75
32	W. P. Scott	Stove	5.00
34	The Western Union Telegraph Co	Telegrams	.40
35	The Thomas Drake Lumber Co	Lumber	22.97
36	Seright & Webster	Boat pumps	8.00
52	Standard Oil Co	Oil	4.00
53	Leslie Erwin	Services with team	.38
54	Edmund Moeser	Traveling expenses	19.60
55	Steamer Jewel	Freight	1.00
56	The Bucyrus Company	Bucket links	335.99
61	T. Roll	Services with team	.50
62	The C. L. Bailey Grocery Co	Brooms	3.25
71	The W. B. Carpenter Co	Letter files, etc	17.77
	March, 1898.		
1	Pay roll	Service	345.00
2	.....do	.....do	645.00
3	.....do	.....do	100.00
4	.....do	.....do	60.00
5	.....do	.....do	27.18
6	.....do	.....do	5.76
7	.....do	.....do	2.88
8	.....do	.....do	12.60
14	The Western Union Telegraph Co	Telegrams	.20
15	Central Union Telephone Co	Toll on messages	2.65
21	Standard Oil Co	Oil	3.70
29	John Schofield	Calking cotton	6.00
30	The Blandy Machine Co	Scraper	3.00
31	George Lilienthal	Paper	1.25
32	Griffith & Wedge Co	Bolts and repairing plates	7.50
33	S. A. Jenkins	Typewriter ribbons and paper	2.85
34	The J. Downerd & Son Co	Coal	8.55
35	M. Luby	Rent of office	41.66
54	W. H. Stanage & Co	Stationery, etc	1.00
68	Pullman's Palace Car Co	Parlor-car fare	.75
66	Cleveland Sawmill and Lumber Co	Pine lumber	208.50
87	Wesley Dutro	White-oak timber	154.44
98	W. H. Stanage & Co	Stationery	1.00
	April, 1898.		
9	Pay roll	Service	60.00
10	.....do	.....do	19.80
11	.....do	.....do	30.96
12	.....do	.....do	31.68
13	.....do	.....do	23.94
14	.....do	.....do	10.08
15	.....do	.....do	44.64
16	.....do	.....do	108.66
17	.....do	.....do	345.00
18	.....do	.....do	100.54
19	.....do	.....do	18.72
20	.....do	.....do	58.64
45	.....do	.....do	645.00
46	.....do	.....do	7.20
58	.....do	.....do	155.88
59	.....do	.....do	105.84
60	.....do	.....do	52.38
61	.....do	.....do	21.78
62	.....do	.....do	2.16
74	Steamer Jewel	Freight	7.50
75	The Blandy Machine Co	Bolts, nuts, channels, and angle irons.	87.53
76	Cash Clothing Co	Burlap bags	1.20
77	Mrs. J. W. Truesdell	Burlap sacks	.80
78	C. Langenberg	.....do	1.52
79	Hardin & Raney	.....do	6.00
80	W. P. Wilson	.....do	8.00
81	Leslie Erwin	Services of teamsters with teams.	31.50
82	William Rakin	Burlap sacks	2.96
83	Charles L. Johnson	Services	1.95

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	April, 1898—Continued.		
84	D. E. Williams	Services	$2.00
85	George Lilienthal	Cap paper	3.50
86	Central Union Telephone Co	Hire of instruments	14.25
88	The J. Downerd & Son Co	Coal	4.50
89	E. W. Webster	Removing crib	8.00
90	The Bailey Drug Co	Oil, paint, etc	110.76
91	Zanesville post-office	Rent of post-office drawer	.75
93	The Blandy Machine Co	Steel pins, plates, bolts, etc	94.01
	May, 1898.		
1	Pay roll	Service	5.76
2	.....do	.....do	14.40
3	.....do	.....do	105.12
4	.....do	.....do	26.28
5	.....do	.....do	10.44
6	.....do	.....do	345.00
7	.....do	.....do	227.25
8	.....do	.....do	193.45
9	.....do	.....do	34.20
10	.....do	.....do	645.00
11	.....do	.....do	76.86
12	.....do	.....do	36.00
13	.....do	.....do	46.80
31	The Bucyrus Co	Castings, etc	199.65
32	C. Whithorn	Rubber stamps	1.75
35	Standard Oil Co	Oil	4.40
37	W. P. Scott	Rope, nails, oakum, etc	208.79
38	Griffith & Wedge Co	Pinions and bolts	11.57
39	F. P. Bailey & Co	Hard oil finish	1.90
46	Pay roll	Service	4.32
74	J. C. Wagner	Services	2.00
76	The Zanesville Hardware Co	Packing	3.10
77	Will Devitt	Services	2.00
78	L. N. Rech	Services with team	1.50
79	Josiah Severance	.....do	1.03
80	Leslie Erwin	.....do	3.50
81	M. Luby	Rent of office	41.66
82	D. E. Williams	Services	2.70
83	Benj. Wright	Services with team	3.00
84	James Beswick	Papering rooms	12.75
85	Robert Fell	Boat pumps and services	26.90
86	The Bucyrus Co	Rubber rings	60.00
87	The American Telephone and Telegraph Co	Telephone messages	2.85
	June, 1898.		
3	Pay roll	Service	645.00
4	.....do	.....do	345.00
5	.....do	.....do	312.50
6	.....do	.....do	286.80
7	.....do	.....do	207.08
8	.....do	.....do	174.12
9	.....do	.....do	59.40
10	.....do	.....do	48.28
11	.....do	.....do	16.56
12	.....do	.....do	10.00
13	.....do	.....do	9.36
14	.....do	.....do	3.60
30	.....do	.....do	.72
46	Mary E. Head	.....do	9.17
52	Standard Oil Co	Oil	4.24
53	Steamer Valley Gem	Freight	.50
57	Free Wright	Services with team	1.13
64	Central Union Telephone Co	Toll on messages	1.20
65	.....do	.....do	1.75
67	The Western Union Telegraph Co	Telegrams	4.25
70	J. Seyler & Bro	Axes, glass, etc	4.95
71	The Thomas Drake Lumber Co	Lumber	141.45
P 72	The American Telephone and Telegraph Co	Telephone messages	5.25
P 74	W. H. Stanage & Co	Stationery, etc	.75
79	Griffith & Wedge Co	Cutting plates, etc	2.20
80	Baker Bros	Soap, brooms, etc	45.00
81	The Bailey Drug Co	Sponges, etc	9.69
82	The Zanesville Hardware Co	Tallow and belt laces	1.31
84	H. H. Sturtevant & Co	Paper	5.04
85	The Grant Dry Goods Co	Towels, curtains, etc	14.79
89	Steamer Lorena	Freight	5.50
93	Standard Oil Co	Oil	4.24

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Detailed statement of expenditures for operating and care of canals and other works of navigation for Muskingum River, Ohio, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	June, 1898—Continued.		
95	Curtis & Co	Lumber, etc	$38.74
96	The United States Express Co	Freight	.95
98	Edmiston-Horney Co	Wrapping paper	2.13
100	Griffith & Wedge Co	Cast-steel pinion	4.50
101	City of Zanesville, Ohio	Water rent	8.87
102	John H. Wheeler	Services	5.50
104	Standard Oil Co	Oil	3.98
106	J. A. Fay & Egan Co	Emery (cup) wheel	7.50
108	Leslie Erwin	Services with teams	8.75
113	Edmund Moeser	Traveling expenses	6.75
P 114	C. Whithorn	Rubber stamps	.20
183	The Zanesville Cycle Co	Carbon paper	1.00
185	Argand Refining Co	Oil	6.89
190	Standard Oil Co	do	4.08
191	The Western Union Telegraph Co	Telegrams	.60
	Total		41,323.92

Summary of expenditures for operating and care of locks and dams on Muskingum River, Ohio, for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$4,478.95
Labor	23,830.45
Fuel	457.60
Expenses	5,179.79
Repairs	7,377.13
Total	41,323.92

Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1898.

Date.	Locality.	Material excavated.	Total cost.
1897.			
July	Taylorsville, Ohio	7,270 yards gravel, sand, and mud, at 9 cents	$654.30
	do	4 stones, at $1	4.00
	do	3 logs, at 50 cents	1.50
	do	1 snag	15.01
	Rokeby Lock, Ohio	3,380 yards gravel, sand, and mud, at 9 cents	304.20
	do	4 logs, at 50 cents	2.00
	Lowell, Ohio	2,200 yards gravel, sand, and mud, at 9 cents	198.00
	do	114 yards dimension stone, at $1	114.00
	do	2 piles, at $6.56	13.12
August	do	4,100 yards gravel, sand, and mud, at 8 cents	328.00
	do	131 yards dimension stone, at $1	131.00
	do	1,000 feet B. M. timber	6.83
	do	5 piling, at $3	15.00
	Devols, Ohio	5,920 yards gravel, sand, and mud, at 8 cents	473.60
	do	2,000 yards sand, at 6 cents	120.00
	Marietta, Ohio	3,000 yards gravel, at 7 cents	210.00
September	do	400 yards gravel, at 9 cents	36.00
	Lowell, Ohio	17,320 yards gravel, sand, and mud, at 6 cents	1,039.20
	do	1 snag	5.28
	Beverly, Ohio	900 yards mud, at 9 cents	81.00
October	do	6,810 yards gravel, sand, and mud, at 7 cents	476.70
	do	5 piling, at $3	15.00
	do	7 timbers, at 50 cents	3.50
	do	2 snags, at $3	6.00
	Baldwins Ripple	4,070 yards gravel, sand, and mud, at 7 cents	284.90
	do	1 snag	3.04
	Luke Chute	2,000 yards gravel, at 6 cents	120.00
	Stockport	200 yards gravel, at 7 cents	14.00
	do	20 yards stone, at 50 cents	10.00
	McConnelsville	4,215 yards gravel, sand, and mud, at 7 cents	295.05
	do	6 piling, at $1.29	7.74

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Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	Locality.	Material excavated.	Total cost.
1897.			
November	McConnelsville	5,760 yards gravel and sand, at 7 cents	$403.20
	do	7 logs, at 50 cents	3.50
	Rokeby Lock	1,660 yards gravel, sand, and mud, at 11 cents	182.60
	do	13 logs, at 50½ cents	6.56
	Philo	6,380 yards gravel, sand, and mud, at 7 cents	446.60
	do	1,400 yards mud, at 10 cents	140.00
December	do	3,630 yards gravel, sand, and mud, at 10 cents	363.00
	do	3,650 yards sand and gravel, at 10 cents	365.00
	Zanesville	590 yards mud and sand, at 10 cents	59.00
		Repairs	185.12
1898.			
January		Watchman and repairs	539.86
February		do	106.00
March		do	194.55
April		do	626.90
May		do	446.93
June		do	359.06
	Rokeby Lock	3,200 yards gravel, sand, and mud, at 5 cents	160.00
	Total		9,575.95

MUSKINGUM RIVER LEASES.

Year ending April 30, 1898.

Location.	Lessee.	Dated.	Expires.
Dam No. 1, Marietta	Phœnix Mill Co	May 1, 1873	May 1, 1903
Dam No. 2, Devola	Gates & Payne	May 1, 1889	May 1, 1909
Dam No. 3, Lowell	F. Wilking & Co	May 1, 1890	May 1, 1910
Do	Rechsteiner Bros	do	Do.
Do	do	Nov. 1, 1892	Nov. 1, 1912
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Dam No. 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	Langenberg & Abrams	May 1, 1890	May 1, 1910
Do	Mary L. Baldwin	do	Do.
Do	D. T. Brown	do	Do.
Do	Isaac D. Spooner	do	Do.
Dam No. 6, Stockport	Schob & Pierrot	May 1, 1889	May 1, 1909
Dam No. 7, McConnelsville	E. M. Stanbery	Sept. —, 1839	
Dam No. 9, Duncans Falls	John Miller	Dec. 31, 1836	
Dam No. 9, Taylorsville	Frazier & Son	do	
Do	John P. Krier	May 1, 1896	May 1, 1901
Do	Lewis H. Krier	Nov. 1, 1896	Nov. 1, 1901
Dam No. 10, Zanesville	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson	do	Do.
Do	do	May 1, 1889	May 1, 1909
Do	Muskingum Coffin Co	May 1, 1890	May 1, 1910
Do	Gary & McLaughlin	do	Do.
Do	T. L. Moorehead	May 1, 1893	May 1, 1913
Do	Muskingum and Ohio River Transportation Co.	Nov. 13, 1897	Nov. 13, 1902
Symmes Creek	Jasper K. McCann	May 1, 1894	May 1, 1900

Year ending May 31, 1898.

Dam No. 10, Zanesville	John Blankenbuhler	June 1, 1892	June 1, 1909
Do	Frederick Abel	do	Do.

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Leases—water power, land, and rental.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate.	Rents collected.
Phœnix Mill Co	Water power	3,000	$350.00	$123.02	$226.98
Gates & Payne	do	9,000	108.00	.....	108.00
F. Wilking & Co	do	7,280	174.72	.....	174.72
Rechsteiner Bros	do	4,446	106.70	.....	106.70
Do	Land	.....	10.00	.....	10.00
E. W. Sprague	do	.....	5.00	.....	5.00
Robbins Bros. *a*	Water power	1,904	100.00	.....	.....
Langenberg & Abrams	do	5,600	114.24	.....	114.24
Mary L. Baldwin *b*	do	5,000	100.00	.....	100.00
D. T. Brown	do	6,033	109.80	.....	109.80
Isaac D. Spooner	do	4,000	100.00	.....	100.00
Schob & Pierrot	do	6,390	230.04	.....	230.04
E M. Stanbery *c*	do	(*d*)	.....	.....	.....
John Miller *c*	do	(*e*)	.....	.....	.....
Frazier & Son *c*	do	(*e*)	.....	.....	.....
John P. Krier *f*	Land	.....	20.40	.....	13.94
Lewis H. Krier *g*	do	.....	30.10	.....	.....
John T. Drone	Water power	7,560	453.60	.....	453.60
Edward Johnson	do	6,029	361.74	.....	361.74
Do	do	7,399	443.82	.....	443.82
Muskingum Coffin Co	do	4,619	207.86	.....	207.86
Gary & McLaughlin	do	4,794	186.96	.....	186.96
T. L. Moorehead	Land	.....	25.00	.....	25.00
Muskingum and Ohio River Transportation Co. *h*	do	.....	25.00	.....	11.67
Jasper K. McCann	do	.....	5.00	.....	5.00
John Blankenbuhler	Water power	2,700	100.00	.....	100.00
Frederick Abel	do	5,200	184.50	.....	184.50
Total		.....	.....	.....	3,279.57

a No collection.
b Lease transferred to Henry C. Baldwin, July 17, 1897.
c Perpetual free lease of water power.
d Enough to propel 10 run of 4-foot 5-inch millstones.
e Enough to propel 15 run of 4½-foot millstones.
f Lease canceled January 6, 1898.
g Lease canceled January 20, 1898, for nonpayment of rents.
h Lease issued November 18, 1897.

COMMERCIAL STATISTICS.

Commerce of Muskingum River during the calendar year ending December 31, 1897.

LOCK NO. 1.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	43	6	.....	49	44
February	16	3	.....	19	16
March	64	14	8	86	64
April	75	25	68	168	86
May	80	27	27	134	81
June	99	57	36	192	112
July	91	47	23	161	108
August	83	29	2	114	91
September	7	13	.....	20	9
October	1	1	.....	2	1
November	40	14	2	56	48
December	64	26	.....	90	68
Total	663	262	166	1,091	728

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Commerce of Muskingum River during the calendar year ending December 31, 1897—Cont'd.

LOCK NO. 2.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	38	1	.....	39	39
February	25	.....	.....	25	25
March	65	2	.....	67	67
April	66	5	3	74	73
May	64	4	4	72	72
June	73	14	3	90	90
July	61	2	3	66	66
August	88	13	5	106	106
September	68	20	2	90	90
October	60	7	.....	67	67
November	60	6	5	71	71
December	55	4	1	60	60
Total	723	78	26	827	826

LOCK NO. 3.

January	38	1	.....	39	39
February	25	.....	.....	25	25
March	63	2	.....	65	65
April	63	2	3	68	68
May	64	9	6	79	77
June	67	16	18	101	91
July	59	2	3	64	64
August	83	13	2	98	96
September	64	17	3	84	82
October	59	6	1	66	66
November	59	6	1	66	66
December	55	2	1	58	58
Total	699	76	38	813	797

LOCK NO. 4.

January	11	4	.....	15	15
February	11	.....	1	12	12
March	51	.....	5	56	56
April	64	.....	7	71	71
May	47	8	17	72	66
June	35	18	16	69	64
July	14	7	25	46	42
August	57	11	22	90	79
September	62	16	29	107	92
October	72	19	10	101	97
November	62	11	4	77	74
December	56	.....	6	62	61
Total	542	94	142	778	729

LOCK NO. 5.

January	2	.....	.....	2	2
February	6	1	.....	7	7
March	25	.....	3	28	28
April	37	.....	6	43	43
May	32	5	9	46	42
June	23	12	12	47	37
July	9	5	5	19	16
August	22	8	14	44	30
September	17	11	11	39	29
October	24	15	11	50	43
November	19	11	6	36	29
December	10	1	.....	11	11
Total	226	69	77	372	317

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Commerce of Muskingum River during the calendar year ending December 31, 1897—Cont'd.

LOCK NO. 6.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	2	.....	2	4	4
February	5	.....	.....	5	5
March	26	.....	5	31	31
April	36	.....	7	43	43
May	28	4	10	42	37
June	20	10	30	60	48
July	6	3	18	27	23
August	20	8	20	48	36
September	13	9	19	41	25
October	18	12	6	36	26
November	18	11	3	32	24
December	11	1	.....	12	12
Total	203	58	120	381	314

LOCK No. 7.

February	3	.....	.....	3	3
March	26	.....	7	33	32
April	35	.....	9	44	44
May	27	5	20	52	48
June	21	12	11	44	36
July	6	6	22	34	31
August	23	10	24	57	46
September	26	11	32	69	43
October	18	14	3	35	26
November	22	11	5	38	31
December	11	.....	3	14	14
Total	218	69	136	423	354

LOCK No. 8.

January	34	.....	.....	34	34
February	15	.....	1	16	16
March	78	.....	.....	78	78
April	95	7	1	103	101
May	87	11	11	109	101
June	85	16	12	113	104
July	74	5	17	96	89
August	78	11	14	103	90
September	63	19	3	85	78
October	67	13	3	83	74
November	69	9	10	88	80
December	53	2	.....	55	55
Total	798	93	72	963	900

LOCK No. 9.

January	32	1	.....	33	33
February	15	.....	1	16	16
March	78	.....	1	79	78
April	94	2	8	104	101
May	84	4	24	112	103
June	84	9	25	118	109
July	77	3	15	95	91
August	76	6	12	94	82
September	73	17	13	103	80
October	66	10	5	81	71
November	77	13	13	103	91
December	70	6	14	90	79
Total	826	71	131	1,028	934

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Commerce of Muskingum River during the calendar year ending December 31, 1897—Cont'd.

LOCK No. 10.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	32	.....	.....	32	32
February	15	1	.....	16	16
March	78	.....	.....	78	78
April	92	2	.....	94	92
May	88	5	2	93	90
June	71	6	3	80	76
July	80	.....	1	81	81
August	77	8	5	90	81
September	62	15	1	78	73
October	65	21	3	89	77
November	60	9	2	71	66
December	56	20	.....	76	71
Total	774	87	17	878	832

SUMMARY.

Lock No.—	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
1	663	262	166	1,091	728
2	723	78	26	827	826
3	699	76	38	813	797
4	542	94	142	778	729
5	226	69	77	372	317
6	203	58	120	381	314
7	218	69	136	423	354
8	798	93	72	963	900
9	826	71	131	1,028	934
10	774	87	17	878	832
Total	5,672	957	925	7,554	6,731

List showing amount of principal items of freight and the number of passengers carried on the Muskingum River for the calendar year ending December 31, 1897.

Articles.	Amounts.	Articles.	Amounts.
Passengers ..... number..	72,512	Lumber ..... tons..	12,243
General merchandise ..... tons..	27,700	Brick ..... do....	2,325
Coal ..... do....	6,523	Hay ..... do....	1,250
Live stock ..... do....	1,850	Salt ..... do....	1,750
Oil ..... do....	1,100	Potatoes ..... do....	305
Wheat ..... do....	2,160	Sand ..... do....	2,662
Corn ..... do....	1,025	Stone ..... do....	4,445
Wool ..... do....	135		

The total commerce was 65,473 tons of freight, valued, approximately, at $3,224,933; and the number of passengers carried, 72,512.

List of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio.

Name of steamer.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Inches.*	
Lorena	141	32	5	24	287
Hazel Rice	126	22½	4	26	138
Sonoma	125	20	3½	23	116
Jewel	116	26	3½	24	95
Valley Gem	125	26½	4	24	156.24
Zanetta[a]	150	35	6	33	164.73
Del Norte	35½	8½	4½	40	5

[a] Side-wheel. Two new lines of transportation established between Zanesville and McConnelsville; steamers Valley Gem and Zanetta; increase in tonnage, 320.97.

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List of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio—Continued.

Name of steamer.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet*	*Inches.*	
A. H. Lawrence	42	7	2½	30	3
Burnadina King	90	18	3½	24	106
U. S. S. Vega *a*	75	12	3½	30	30
Catharine Davis *b*	135½	27	3½	22	210
Barnsdall *b*	130	26	4	30	127
Valley Belle *b*	127	22	3½	27	127
D. T. Watson *b*	99	17	3½	29	81
Venus *b*	90	18	3½	20	116
Mary E *b*	80	13½	3	30	19
Eliza *b*	110	25	3½	22	95
Will J. Cummings *b*	160	30	4	20	281
Troubadour *b*	100	18	3	22	60
Lula F *b*	85	18	3	20	40
Manhattan *b*	90	14	7½	60	90
Adelle *b*	130½	23	3½	60	90
Harry Brown *b*	205	35	5½	36	381.13
Urania *b*	160	28	5	20	258
Kanawha *b*	180	34	5	20	295

a Propeller. *b* Only occasional trips on Muskingum River.

REPORT OF MR. EDMUND MOESER, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, June 30, 1898.

MAJOR: I have the honor to submit the following report on operating and care of locks and dams on the Muskingum River for the fiscal year ending June 30, 1898:

All work carried on by hired labor and competitive purchase of material was done in accordance with the approved project for the year and for incidental repairs made necessary by accident.

Interruptions to the operation of the ten locks were those caused by ice closing the river for nine days in December, 1897, and January, 1898, and by high water for five days in March, 1898. Lock No. 1, at the mouth of river, was closed fifteen days in September, 1897, while making repairs to lock floor; but this delay was unimportant, as the lock was practically inaccessible at that time on account of low water in the Ohio River. At the close of the year all the locks remain in good working order.

There was a phenomenal flood in March, the water reaching a height of 31.7 feet above the normal level of pool at the Zanesville lock, that being 2.8 feet higher than the great flood of 1884. The only damage done was to canal banks and embankments behind abutments, all of which can be repaired without excessive cost. The canal at No. 9 (Taylorsville), 1 mile in length, was made useless by the failure of part of its banks. As this canal is not now required for navigation, but serves to furnish certain water power with which the United States is charged, the repairs made were in accordance with this fact.

The other four lateral canals along the river, aggregating 2½ miles in length, have been maintained in good condition, with depths at mean low water generally exceeding the 6-foot depths on miter sills of locks. All the locks were kept clear of sedimentary deposits and drift, and building, lock gates, and lock irons were repainted when necessary.

The following is a detailed statement of work done during the year:

LOCKS AND DAMS.

Lock and Dam No. 1, Marietta.—The project for repair of lock floor at upper end of lock was not fully accomplished, all attempts made to unwater the lock chamber with the means at hand proving futile. A coffer was placed across the lock chamber at middle gate recesses, and material banked against the upper gates until they were perfectly tight; but the leakage underneath the lock walls, together with water carried in by several large springs under floor of lock, exceeded the capacity of the two large centrifugal pumps used, so that it was not possible to lower water in lock more than a few inches. It was therefore deemed advisable to limit further operations to the removal of débris of broken floor, filling gravel and concrete into

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cavities under the floor and tight material around lock walls, with a view to stopping the infiltration of water underneath them. The amount of gravel thus used was 6,470 cubic yards. Timber bulkheads were placed across the outside of all filling culverts in lock walls, and to prevent scour around the head of river wall a protection crib, 25 feet in length, was constructed from head of river wall to pier above. A covering of stone was also placed over the material banked against river wall of lock.

All disintegrated stone in chamber faces of lock walls and upper miter-sill wall was dressed back and cavities filled with concrete. The upper gates of lock were rebuilt by replacing all the arms above pool level with 7,122 feet, B. M., oak pieces, which had been prepared during the previous year and were used temporarily in the construction of the lower coffer for repair of lock floor. The lock master's house, on the river bank opposite lock, was thoroughly repaired by renewing windows, doors, ceilings, roofs, and porches, and by repapering and repainting. Incidental repairs were necessary to turbine machinery on lock walls, lock irons, waiting room, and storehouse in lock yard. Sediment was cleaned from lock and drift from dam and lock, when required.

For the ordinary commerce of the river one-half of this lock is sufficient, and with the middle gates now in use it can be operated much more rapidly, on account of the lesser time required to fill and empty. The use of the whole chamber of lock is limited to passing unusually large steamboats and some rafts. Under present conditions this can be done with safety when the lift does not exceed 7 feet, the low-water lift being about 12 feet. During the past year there has been no delay or inconvenience to navigation on account of the existing conditions, and for the present, at least, it would not be advisable to take any further steps toward restoring the broken lock floor.

Lock and Dam No. 2, Devols.—Rebuilt the crest of dam for 36 feet and the lower apron for 101 feet of its length. All empty spaces in dam were packed with stone. Replaced 4 decayed arms of lock gate with new timber.

The deposits of sediment by the river in freshets required repeated cleaning out of lock chamber. The high water of March necessitated repairs to storehouse and repapering and repainting of the lock master's house. The following amounts of material were expended on the work:

White oak timber	feet B. M..	17,040
Stone	cubic yards..	335
Driftbolts	pounds..	2,400

Lock and Dam No. 3, Lowell.—All expenditures were for repairs made necessary by emergency. They consisted in replacing the longitudinal timbers on 55 feet of the second step of dam, refilling with stone about 50 feet of the lower apron, and resheeting the first and second steps for a distance of 84 feet; 8,200 feet timber and 95 cubic yards stone was used.

The needles for dam at head of lock were cleaned and restacked in storehouse, lock implements and winches for valves were repaired, canal banks kept in good condition, and a small washout behind land wall of lock refilled with earth.

Lock and Dam No. 4, Beverly.—Originally the dam at this place was the shortest on the river, 170 feet additional spillway being provided at the left end for all stages above 7.3 feet on crest of main dam. The spill dam is only occasionally submerged, a fact which compelled frequent renewing of the timbers of which it was constructed. To obviate this the exposed timber steps on front were replaced by a concrete slope wall, 17.8 feet high and 170 feet long, after forming back of slope with rubblestone filled over steps. The total amounts of ingredients mixed for the concrete masonry and slope, including 1-inch facing, was 240 barrels Portland cement, 200 cubic yards sand and gravel, and 100 yards stone, which made 225 cubic yards masonry in place.

Drift was cleared from the canal and mud removed from around lock gates after each freshet; leakage around head gates at mill race was stopped with planking; winches on lock walls were repaired; 2 broken bed plates of machinery on guard gates were replaced; 2 small washouts in embankments above lock were refilled, and 100 feet of the fence around lock yard was replaced.

Lock and Dam No. 5, Luke Chute.—The joints over 2,185 square feet of the lock walls were raked out and repointed, and cavities in faces of walls refilled with concrete. Lower apron of dam, next to lock, was rebuilt for 147 feet of its length; the amount of materials required was 38,500 feet B. M. oak timber, 2,600 pounds driftbolts, and 240 cubic yards of stone. Repaired and made serviceable two valve operating winches on lock walls; replaced on their foundations two buildings in lock yard; rebuilt front porch of lock master's house and repainted exterior of house, all damaged by high water. Cleared from lock yard a large amount of drift and rubbish.

Lock and Dam No. 6, Stockport.—The lock and dam and their appurtenances remained in good condition. Minor liabilities were incurred for work done in connection with protection of embankment at lock during continuance of high water,

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for removal of sediment from lock chamber, repapering the lock master's house, and rebuilding one outbuilding carried away by flood.

Lock and Dam No. 7, McConnelsville.—The old wooden drawbridge across the canal, belonging to the United States, was replaced with a plate-girder bridge, consisting of 2 girders, each 4 feet deep and 90 feet long, with transverse floor channels and oak joists resting on the lower flange of girders and supporting a plank roadway 12 feet between webs of girders. The substructure of bridge, pivot pier, and 2 rest piers were repaired and modified to correspond with new superstructure and its operating machinery. The bridge was finished and ready for use June 23, 1898. The superstructure, with apparatus for swinging the draw, was built by the New Columbus Bridge Company, of Columbus, Ohio, and cost complete $799.00. Cost of making repairs to substructure was $443.88.

With the view of protecting the bank affected by eddy below right abutment of dam, 106 yards of earth was filled over the embankment behind abutment, and the crib extension below abutment, 100 feet in length, was rebuilt and filled with stone. The following amounts of material were expended on crib:

Stone	cubic yards..	235
White oak timber	feet B. M..	15,700
Driftbolts	pounds..	1,250

Repairs were made to the dam by refilling with stone a section of the lower apron, rebuilding 60 feet of the front wall, and resheeting top of lower apron for a corresponding length.

Labor was employed handling materials and supplies for shipment to various places, keeping canal clear of drift, cleaning lock, and repainting gates. During the March flood unusual efforts were made toward protecting the embankments at both ends of dam, and no serious damage occurred. After the flood it was necessary to repair and clean machinery in the carpenter shop at this place.

Lock and Dam No. 8, Eagleport.—The project for repairing and protecting the right abutment of dam and its crib extension was performed. Relaid 7 yards of masonry on lower end of the abutment with concrete, dumped 332 cubic yards of large stone blocks around abutment and crib, and rebuilt the crib extension 56.5 feet long. Cavities under abutment were packed with stone; the crib extension was refilled and top repaved. Material expended: 10,000 feet B. M. oak timber, 2,050 pounds driftbolts, 340 cubic yards rubblestone, and 332 cubic yards of large stone. An extraordinary deposit of sediment and débris of all kinds was found in lock chamber after subsidence of the March, 1898, flood; its removal required six days of uninterrupted exertion. A washout in terreplein of lock was refilled with 208 yards of earth, and lock yard placed in presentable condition. Periodical cleanings have been necessary to keep lock gates in good condition. Minor repairs were made to gate irons.

Lock and Dam No. 9, Taylorsville.—Repairs were made to the dam. They consisted in placing new longitudinal timbers and sheeting on 55 feet of the lower apron. Materials used: 6,493 feet B. M. timber, 385 pounds driftbolts, and 26 yards stone.

The only work done at lock was for cleaning sediment from around gates, removing drift and snags from upper approach, and repainting gates and maneuvering irons. The storehouse and waiting room were repainted.

The old lateral canal at this place, although not used for navigation since completion of new lock at one end of dam, is maintained for the purpose of furnishing water power to the mill on its bank, a charge assumed by the United States with the control of the Muskingum River.

The great flood of the past winter injured the canal banks to the extent that the mill was deprived of water power. Temporary relief was promptly afforded by a low embankment thrown across the canal below the branch race which conveys water to mill, and water supplied through valves in guard gates at head of canal. Repairs of a more permanent nature were then made to the damaged canal by refilling 280 feet of earth embankments, replacing slope walls, and rebuilding the conduit running under canal embankment from canal to mill race. The following is a statement of material expended for repair of canal:

Earth filling	cubic yards..	3,105
Paving stone	do....	83
White oak timber	feet B. M..	8,207

All paving stone used was recovered from destroyed embankment.

Lock and Dam No. 10, Zanesville.—The dangerous portion of the old step dam was replaced with 220 feet of slope dam and several empty cribs in old part of dam were refilled with stone.

The following is the total amount of material expended in this work:

Timber	feet B. M..	135,600
Stone	cubic yards..	1,041
Driftbolts	pounds..	17,155

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Reconstruction of the lock at this place having been indefinitely postponed, all repairs are with a view of keeping it in operation without costly work. During the past year worthless coping on walls was replaced with concrete over an area of 936 square feet, new spar poles were made for lower gate operating machines, and lock irons generally repaired.

The entire guide crib below land wall of lock, 90 feet in length, was rebuilt. The crib is 14 feet wide at bottom, 8 feet at top, and 19½ feet high. The amount of materials expended is 32,120 feet B. M. oak timber, 2,600 pounds driftbolts, and 440 cubic yards stone.

The collapsed stone revetment on 200 feet of canal bank above land wall of lock was replaced with concrete. Suitable oak posts were embedded in face of concrete for protection of boats drifting against wall. The bank behind wall was refilled with cinders and gravel. Material expended: 180 yards concrete, 807 feet B. M. timber, and 140 yards filling material.

The waiting room, storehouse, and lock gates were repainted and canal banks kept in good condition.

BOATS.

The U. S. dredge *Malta* has been usefully employed throughout the working season in dredging out canals and making excavations through shoals in the open river. Snags, rocks, and other obstructions were removed and dams backed with gravel where required. The work accomplished was the removal of 89,425 cubic yards of material, 11 snags, 269 stones, and 62 logs and timbers by working over a distance of 11,660 feet.

The following points between mouth of river and Zanesville received attention: At No. 1, Marietta, dumped material around upper end of lock and removed coffer above upper gates; at No. 2, Devols, dug material for filling at No. 1, dredged out the lower approach to lock; at No. 3, Lowell, dredged out the canal; at No. 4, Beverly, the canal; at Baldwin's ripple, 1½ miles below No. 5, the upper end of bar; at No. 5, Luke Chute, lower approach to lock and backing of dam; at No. 6, Stockport, the lower approach to lock; at No. 7, McConnellsville, the canal and backing of dam; at No. 8, Eagleport, the lower and upper approaches to lock; at No. 9, Taylorsville, the left channel at bar below old lock, where the dredge worked over a distance of 1,410 feet, the channel below new lock, head of canal and backing of dam; at No. 10, Zanesville, the canal.

The dredge fleet was placed in winter quarters at Zanesville, December 24, 1897. Towing for the dredge was done by the hired steamboat *Hazel Rice*. Extensive repairs were made to dredge from January to July, 1898.

The old lock at No. 9 was converted into temporary ways for docking boats belonging to the United States, at a cost of $150. The dredge, two dump scows, and steamer *Vega* were docked and hulls repaired and calked, and making them again serviceable, especially that of the dredge, which had received no attention since its construction in 1888.

The Government steamer *Vega* has been of great service in towing material used at the various works.

The delivery of material needed for reconstructing the floating pile driver was not completed until towards the close of the fiscal year. Nothing was therefore done in this matter except receiving and caring for the lumber and iron.

LANDS.

A lease was issued to the Muskingum and Ohio River Transportation Company for $\frac{44}{100}$ acres of land on canal bank at Zanesville, Ohio, to be used for warehouse purposes.

BRIDGES.

During the flood of March, 1898, the draw of the Beverly-Waterford bridge, 25 miles above mouth of river, was carried off its piers and lodged in river about 1,000 feet below bridge. The wreckage has not yet become an obstruction and its removal by the owners has been provided for. At the same time the abutment on shore side of draw space of the Taylorsville bridge, 67 miles above mouth of river, fell out into the channel; immediate steps were taken by the owners for the removal of the débris and no serious delays to navigation have occurred.

Respectfully submitted.

EDMUND MOESER, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

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F F 7.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The act of Congress of June 3, 1896, appropriated $1,500 for continuing the work in accordance with the original project, adopted in 1877, viz, removing such obstructions as rocks, snags, overhanging trees, etc., from the stream above Burning Springs, W. Va., about 40 miles above Parkersburg, so as to aid light-draft steamboat navigation and the floating of timber to market.

Work was resumed in August and continued until September 11, 1897, when operations were suspended on account of extreme low water, which prevented economical prosecution of the work. The river was gone over from Dam No. 5 to Creston, W. Va. (head of ordinary steamboat navigation), a distance of 8 miles, and many troublesome obstructions removed.

The commercial statistics are given in the report for operating and care of lock and dam on Little Kanawha River, West Virginia.

This work was under the efficient care of Mr. B. F. Thomas, resident engineer, until May, 1898, since which date it has been under the similar care of Mr. Edmund Moeser, resident engineer, whose report is hereto appended.

Money statement.

July 1, 1897, balance unexpended	$1,497.46
June 30, 1898, amount expended during fiscal year	694.15
July 1, 1898, balance unexpended	803.31

Appropriations.

August 14, 1876	$7,300	August 5, 1886	$16,875
June 18, 1878	18,000	August 11, 1888	25,000
March 3, 1879	18,000	September 19, 1890	40,000
June 14, 1880	15,000	June 3, 1896	1,500
March 3, 1881	40,000		
August 2, 1882	31,000	Total	212,675

NOTE.—For list of boats plying Little Kanawha River, and commercial statistics, see report for operating and care, etc., Little Kanawha River, West Virginia.

REPORT OF MR. EDMUND MOESER, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, June 30, 1898.

MAJOR: I have the honor to submit the following report on improving Little Kanawha River, West Virginia, during the fiscal year ending June 30, 1898.

This work is carried on under an item in the river and harbor act of June 3, 1896, and subsequent project approved by the Chief of Engineers July 6, 1896, for removal of obstructions that have reformed in the river above Dam No. 5. In accordance with these provisions a party was organized in August, 1897, and beginning at Lock and Dam No. 5, 40 miles above mouth of river, worked upstream to Creston, W. Va., a distance of 8 miles, clearing the river within the limits of the normal level of pool, and to the head of ordinary steamboat navigation, of such obstructions as over-

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hanging trees, snags, and stumps. In detail the work done over this stretch of river is as follows:

Trees cut down, trimmed, and cut into short lengths	762
Trees bored for blasting	42
Trees girdled and deadened	77
Fallen trees trimmed and cut into short lengths	123
Stumps removed	85

Operations were suspended September 11, 1897, on account of the extreme low stage of water which prevented economical prosecution of the work above the limits of pool No. 5.

The clause contained in the act of June 3, 1896, pertaining to Little Kanawha River, evidently intended to provide for the maintenance of light-draft navigation over the 37 miles of stream between Lock No. 5 and Grantsville, W. Va., heretofore improved with 6 dikes. With this in view an examination of the river between the two points was made by my predecessor, Assistant Engineer B. F. Thomas, and an estimate of the work required together with project for its performance submitted September 16, 1897.

Respectfully submitted.

EDMUND MOESER, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

[Extract from report of Mr. B. F. Thomas, resident engineer.]

Report upon the obstructions to navigation in that part of Little Kanawha River lying above the head of ordinary steamboat navigation, between Creston and Grantsville, W. Va.:

As the journey over this part of the river was made downstream, I will note the obstructions in this manner.

The Government dike at Leaf bank, just below Grantsville, and 29¼ miles above Creston, has done great good in directing and confining the waters, and sediment has filled in behind it until the dike itself has the appearance of being part of the bank. It will require no repairs, although the timber has about all decayed. The first work below Grantsville is at Robinson Run, where there are five large rocks in bend and snags just below at the Bell farm. The chute should also be cleaned at the Bell bend and some rocks blasted out near water's edge. There are two rocks at Rogers, above Big Root Creek, 21¼ miles above Creston, to take out, and some at Big Root Ripple, 20¼ miles from Creston. The dike at this shoal is of great advantage and requires no repairs.

There are quite a number of trees and snags to remove above Brooksville and a drift just below Yellow Creek, and some rocks to blast a little lower down. Stocking Heel shoal, 18¼ miles above Creston, needs cleaning and the chute straightened. The dike at this point has been of great benefit and requires no repairs.

Around the Big Bend there are quite a number of snags to remove, fallen trees to trim up, and overhanging trees to top.

There are snags both above and below Anna Maria Creek, 15¼ miles above Creston. At this place the Government dike has been of great advantage to the river.

A little lower down, on Knight's farm and opposite there, are some fallen trees to take out and some trees to top.

There are some bad drifts at Aaron Pettil's and some rock below the "neck" of the Big Bend and just above the "Devil's Race Track," which itself needs cleaning of bowlders.

There are some leaning trees at Mrs. Blacksheer's and below and dead timber at May's.

Some rocks should be blasted at Fishpot Shoal and some fallen trees a mile below should be taken out.

There are snags, fallen trees, and leaning trees to remove in the Lending Creek neighborhood, 8 miles above Creston. The dike here, like all the others, has been of great benefit in forming a navigable river, and is the last of the five below Grantsville to report upon, as the one at West Fork Ripple is in slack water now.

There are some rocks above Nailor Bend, 5¼ miles above Creston, and some below the shoal, and also some trees to remove.

Some blasting should be done at what is known as County Line Rocks, and the shoal below needs some work.

There are some snags and trees below Straight Creek and leaning trees above Katy Run, where some blasting will be necessary.

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Many tree tops are alongshore near the "Devil's Tea Table" and above Rock Run, and there are some rocks at Beaver Rocks, 4¼ miles above Creston, and at Scott's Rock.

A few snags have formed in the head of pool at Flat Ripple, 2½ miles above Creston.

It is recommended that the work be postponed until a favorable stage of water occurs next season, say in July or August.

The estimated cost is as below:

Explosives and other articles to be purchased	$350.00
1 master laborer and blaster, 1 month	75.00
10 laborers, 24 days each, at $1.20	288.00
1 boat, 1 month	30.00
	743.00

F F 8.

OPERATING AND CARE OF LOCK AND DAM ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

This lock and dam, known as No. 5, was constructed under the additional project for improving Little Kanawha River, West Virginia, of 1880, and was opened to navigation on December 2, 1891, since which time it has been operated and kept in repair under the indefinite appropriation.

Navigation was suspended through this lock for 129 days, owing to low and high water, to ice, and to the leaky condition of the dams belonging to the navigation company below.

The valves of lock caused some trouble during the year, and on May 1 one of the emptying valves became entirely unserviceable. The extent of the damage can not be ascertained until low water, but steps have been taken for its repair. The dam required some resheeting, filling, and backing. This was done, and the lower apron anchored to the masonry of the lock. The lower guide crib of lock was reduced 30 inches and stone for paving top of same quarried. A fill was made behind this crib. The upper guide crib was paved. Some bank protection was also done. Stone for cribs and bank protection was quarried.

This work was under the efficient care of Mr. B. F. Thomas, resident engineer, until May, and since then has been under the similar care of Mr. Edmund Moeser, resident engineer, whose report is herewith appended.

The following is a statement of the amounts and dates of all allotments for this work:

November 28, 1891	$1,500.00	July 24, 1896	$830.72
July 15, 1892	4,426.65	July 27, 1897	1,684.03
July 21, 1893	3,837.97		
July 16, 1894	3,491.03	Total	19,148.57
July 20, 1895	3,378.17		

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Detailed statement of expenditures for operating and care of canals and other works of navigation applied to Little Kanawha River, West Virginia, during the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	For what paid.	Amount.
	August, 1897.		
41	Pay roll	Service	$95.00
42	....do	....do	8.40
61	Niswander Hardware Co	Cement, etc	4.65
	Total		108.05
	September, 1897.		
102	Pay roll	Service	193.55
103	....do	....do	95.00
184	....do	....do	115.65
232	The Atlantic Refining Co	Oil	6.08
251	The W. H. Smith Hardware Co	Fuse	1.95
257	The Pickering Hardware Co	Drills	6.30
279	The Western Union Telegraph Co	Toll on telegram	.20
282	L. E. Tanner	Stone	20.00
284	Wirt Ball	Supplies	1.24
285	....do	Nails, etc	.95
287	G. W. Righter	Oak lumber	1.50
	Total		442.42
	October, 1897.		
6	Pay roll	Service	295.00
106	C. Whithorn	Rubber stamps	.50
	Total		295.50
	November, 1897.		
89	Pay roll	Service	95.00
	Total		95.00
	December, 1897.		
16	Pay roll	Service	27.30
17	....do	....do	95.00
165	B. F. Thomas	Traveling expenses	18.40
	Total		140.70
	January, 1898.		
1	Pay roll	Service	95.00
75	D. S. Hopkins	Hire of barge	2.00
188	Pay roll	Service	95.00
	Total		192.00
	February, 1898.		
123	Pay roll	Service	95.00
	Total		95.00
	March, 1898.		
77	The W. H. Smith Hardware Co	Hardware, etc	13.71
	Total		13.71
	April, 1898.		
24	Pay roll	Service	95.00
	Total		95.00
	May, 1898.		
43	Pay roll	Service	95.00
	Total		95.00
	June, 1898.		
35	Pay roll	Service	95.00
P 74	W. H. Stanage & Co	Stationery, etc	.75
90	The W. H. Smith Hardware Co	Lime, etc	5.40
P 192	Pay roll	Service	50.00
	Total		151.15

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Summary of expenditures for operating and care of lock and dam on Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$250.20
Labor	1,045.00
Expenses	34.63
Repairs	393.70
Total	1,723.53

List showing amount of principal items of freight and the number of passengers carried on Little Kanawha River, West Virginia, for the calendar year ending December 31, 1897.

Articles.	Amount.	Articles.	Amount.
Coal ..... tons	1,202	Miscellaneous ..... tons	23,400
Lumber ..... do	10,547		
Staves ..... do	15,190	Total	127,943
Timber ..... do	61,307		
Ties ..... do	16,297	Passengers ..... number	22,000

The total commerce of 127,943 tons of freight is valued, approximately, at $2,300,000.

List of steamboats plying on Little Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
W. A. Hilton	Stern-wheel	105	22.5	3.6	67.54
Burnadina King	do	90	18	3.5	106
D. T. Watson	do	90	17	2.6	80.45
Mary E	do	86	13.6	3.6	19.34
Lulu F	do	98.4	15.1	2.6	37.16
Bartlett	do	95.8	14	3.4	56.18

Report of lockages on the Little Kanawha River, West Virginia, for the calendar year ending December 31, 1897.

LOCK NO. 5.

Month.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.	Number of lockages.
January	41	8	.....	1	50
February	39	15	71	22	147
March	39	18	229	17	303
April	55	17	256	23	351
May	53	22	282	6	363
June	35	11	169	10	225
July	41	19	190	20	270
August	22	4	46	9	81
September	.....	.....	.....	1	1
October	.....	.....	.....	.....	.....
November	51	20	45	21	137
December	62	18	67	27	174
Total	438	152	1,355	157	2,102

REPORT OF MR. EDMUND MOESER, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Zanesville, Ohio, June 30, 1898.

SIR: I have the honor to submit the following report on operating and caring for Lock and Dam No. 5 and their appurtenances, Little Kanawha River, West Virginia, during the fiscal year ending June 30, 1898:

Mr. B. F. Thomas, assistant engineer, had local charge of this work until May 12, 1898.

The lock is situated about 40 miles above the mouth of river at Parkersburg, W. Va. Below it the Little Kanawha Navigation Company has four locks and dams, but owing

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to the condition in which the dams are kept it is only during a wet season that navigation below Lock No. 5 is maintained with certainty. During the past year the lower miter sill was out of water for forty-six days in September, October, and November, and for seventy-five days the navigable depth in lock was less than 3 feet. Other interruptions to the operations of the lock were ice closing the river for four days, and four days' suspension of lockages on account of high water.

The following is a detailed statement of work done during the year:

Lock.—The filling and emptying valves were refastened to their shafts by drilling holes and driving pins through valves and shafts; a total of 12 pins were used. The spaces between valve frames and masonry were packed with soft wood to prevent further wear and stop leakage. This work was accomplished in August and September, 1897, when the stage of water was so low that no coffers were required. On May 1, 1898, one of the emptying valves became unserviceable, necessitating the placing of a temporary bulkhead across culvert opening. The exact nature of the damage to valve can not be ascertained until extreme low water sets in, but steps have been taken for its repair. In the meantime the lock is being operated with one emptying valve.

Dam.—Resheeted two steps of dam with 50 pieces timber; refilled empty cribs with 24 cubic yards stone; backed the dam with 40 cubic yards broken stone; fastened the lower apron to masonry of lock with a large anchor bolt and replaced worthless longitudinal timbers, aggregating 80 feet in length, in lower apron of dam.

The following amounts of materials were expended:

White oak timber	feet B. M..	5,760
Stone	cubic yards..	64
Bolts	pounds..	900

Guide crib below land wall of lock.—Removed 4,000 feet B. M. timber and 80 cubic yards stone, thereby reducing height of crib 30 inches throughout its entire length of 100 feet. Prepared the top of crib for paving and quarried 1,000 pieces paving stone for same. Filled 100 yards earth behind crib to complete terreplein of lock, and placed a covering of stone over this fill to protect it from erosion during high stages of water.

Guide crib above land wall of lock.—Quarried, boated to lock, and paved the top of this crib with 400 pieces paving stone.

Bank protection.—Quarried 130 cubic yards stone for riprapping bank below lock and placed 40 yards after grading and preparing bank.

Miscellaneous.—Incidental repairs were made as required, and grounds kept in excellent condition by the lockmaster and assistant.

Respectfully submitted.

EDMUND MOESER, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 9.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William. W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The present project for the improvement of this stream—that is, the modified project of 1875—provides for dredging channels where needed and the extension of 6 feet of slack-water navigation for a distance of about 96 miles upstream from the mouth of the river in the Ohio, at Point Pleasant, W. Va., by the construction of locks and dams (Annual Report, Chief of Engineers, 1875, Part II, pages 90–98). This project provided for twelve locks and dams, three locks with fixed dams in the upper portion of the river and nine locks with movable dams in the remainder of the river. This was changed later on, so that there should be but two locks with fixed dams in the upper river and eight locks with movable dams in the remainder of the river. The two locks with fixed dams in the upper part of the river and five of the locks with mov-

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able dams in the remainder of the stream are completed and in operation, as shown in the table printed on page 2247 of the Annual Report of the Chief of Engineers for 1896, Part IV.

Dam No. 9.—The contractors, Zimmerman, Truax & Sheridan, completed their work at this locality on May 10. The work done consists in building weir foundations, shore abutment, and abutment crib; placing fixed irons, cushion blocks, and guide sills, and grading and riprapping banks. They removed the cofferdam and cleaned up the grounds. The weir of the pass is 284 feet long, being closed by 71 Chanoine wickets.

During the year the lock gates were completed and hung, the weir wickets finished and put in place, and the lock and dam put in order for operating, by hired labor. The dam was regularly raised on June 25. There still remains some work to be done, but the lock and dam will be put in operation on July 1, 1898.

Dam No. 10.—The work to be done under contract was completed by Zimmerman, Truax & Sheridan on March 7. It consisted in building weir foundations, shore abutment, and abutment crib; placing fixed irons, cushion blocks, and guard sills, and removing cofferdam and rubbish from grounds.

The lock gates were built and hung, the weir wickets finished and placed, and work in putting the lock and dam in order to operate almost finished by hired labor during the year. Although there still remains some work to be done, this lock and dam is practically finished and will be put in operation soon after July 1.

Dam No. 11.—Thomas Mumford continued work under his contract through the year. Progress was much retarded by rises in the river and bad leaks in the cofferdam. Quicksand was also encountered and gave considerable trouble. The contractor completed his work inside the cofferdam on June 29, including a timber crib apron to dam, which was not originally contracted for, thought at first unnecessary owing to the depth of hardpan, but later decided advisable, and authorized. The hired-labor force completed the lock gates, put panels in weir wickets, and placed in position almost all of the movable parts of weir.

Miscellaneous work.—Chain and clevises were received from the contractor, Henry B. Newhall, for Dams Nos. 9, 10, and 11; also, some for repair of completed works. The contractor at first furnished chain made from steel, which on inspection failed to stand the test. The contractor thereupon furnished a chain from good iron, which stood the tests well.

Three service boats were built by Calderwood & Hanna, contractors, for use at Dams Nos. 9, 10, and 11.

Proposals were invited and opened for constructing lock houses at sites of Dams Nos. 9 and 10.

U. S. towboat *Bee* and dredge were employed during the year deepening and widening the permanent towing channels, and on such other work as was found necessary, dredging 52,470 cubic yards of gravel and removing 535 cubic yards of stone and 199 snags.

Accompanying this report are ten photographs of Dams Nos. 9, 10, and 11, which, taken in connection with those shown in the Annual Report for 1897, form a complete illustration of these works.

This work has been carried on with great thoroughness and efficiency by Mr. Addison M. Scott, resident engineer, whose report, giving the progress of the work in detail, is herewith appended.

A statement of the commercial statistics is given under operating and care, etc., Great Kanawha River.

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Money statement.

July 1, 1897, balance unexpended		$533,679.25
June 30, 1898, amount expended during fiscal year		234,024.48
July 1, 1898, balance unexpended		319,654.77
July 1, 1898, outstanding liabilities	$7,529.51	
July 1, 1898, amount covered by uncompleted contracts	111,307.11	
		118,836.62
July 1, 1898, balance available		200,818.15

Appropriations.

March 3, 1873	$25,000	August 5, 1886	$187,500
June 23, 1874	25,000	August 11, 1888	350,000
March 3, 1875	300,000	September 19, 1890	300,000
August 14, 1876	270,000	July 13, 1892	225,000
June 18, 1878	222,000	March 3, 1893	500,000
March 3, 1879	150,000	March 2, 1895	580,700
June 14, 1880	200,000	June 4, 1897	273,000
March 3, 1881	200,000		
August 2, 1882	200,000	Total	4,208,200
July 5, 1884	200,000		

Abstract of proposals for building six lock-houses, with outbuildings, at Locks Nos. 9 and 10, Great Kanawha River, received in response to advertisement, dated May 14, 1898, and opened at Charleston, W. Va., June 15, 1898, by Addison M. Scott, Assistant Engineer, for Maj. William H. Bixby, Corps of Engineers.

No.	Name of bidder.	Lock-houses at Lock No. 9.				Lock-houses at Lock No. 10.				Total bid.
		Lock-houses, etc., No. 3.	Price bid for masonry (48 cubic yards).	Price bid for excavation (135 cubic yards).	Price bid for pier stones (No. 36).	Lock-houses, etc., No. 3.	Price bid for masonry (48 cubic yards).	Price bid for excavation (135 cubic yards).	Price bid for pier stones (No. 36).	
1	L. G. Tyree; E. Presby	$2,065.00	$4.00	$0.25	$1.00	$2,065.00	$4.00	$0.25	$1.00	$4,653.50
2	P. A. Kenney; James H. Barker	2,160.00	3.75	.35	2.75	2,235.00	4.50	.35	3.00	5,092.50
3	A. C. Calderwood; W. H. Hanna	2,545.50	4.00	.25	1.00	2,545.50	4.00	.25	1.00	5,614.50
4	C. C. Barr; M. O'Neill	2,249.70	3.45	.45	1.25	2,249.70	3.45	.45	1.25	5,042.10
5	D. Minotti; Charles L. Summers	1,870.80	3.50	.35	.90	1,870.80	3.50	.35	.90	4,236.90
6	Joseph Wildman; John S. Gilliland	2,469.33	4.50	.40	2.00	2,469.33	4.50	.40	2.00	5,622.66
7	Henry Dilcher *a*	1,852.32	3.25	.30	1.00	1,852.32	3.25	.30	1.00	4,169.64
8	David Eagan	2,425.00	4.25	.27	1.15	2,500.00	4.50	.27	1.25	5,504.30
9	W. L. Porter	2,052.00	3.75	.40	1.25	2,052.00	3.75	.40	1.25	4,662.00
10	Morgan & Gardner	2,089.50	3.50	.25	2.00	2,089.50	3.50	.25	2.50	4,744.50
11	Henry Crawford; James W. Crawford	2,425.00	3.60	.30	1.50	2,425.00	3.60	.30	1.50	5,384.60
12	The A. F. Withrow Lumber Co	3,400.00	4.00	.25	*b* 6.00	3,400.00	4.00	.25	*b* 6.00	7,251.50
13	N. S. Stark; H. A. Stark	1,950.00	3.90	.22	.90	1,950.00	3.90	.22	.90	4,398.60

a Recommended for acceptance.

b Per cubic yard.

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General view of work from the top of the bank near m. (See views taken the same day inside the cofferdam.) The lock was completed except ext to the lock) were finished in 1896.

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Looking inside of coffe progress.

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Looking inside the cofferdam for the weir pa round. The coping and sills are in place

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Inside the cofferdam for the weir part of the abutment. Wickets in foreground lowered. The chains for the wickets are, 4 feet. Bridge trestles 12 feet high, spaced 8 feet apart.

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From left or abutment bank looking inside the coffer ditch, etc., for the foundation of the weir in progress. The lock (shown in the distance) and center pier were finished in 1896.

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LOCK AND D

Showing the weir part of the dam (from center pier lo wicket and trestle chains and part of the aprons for the

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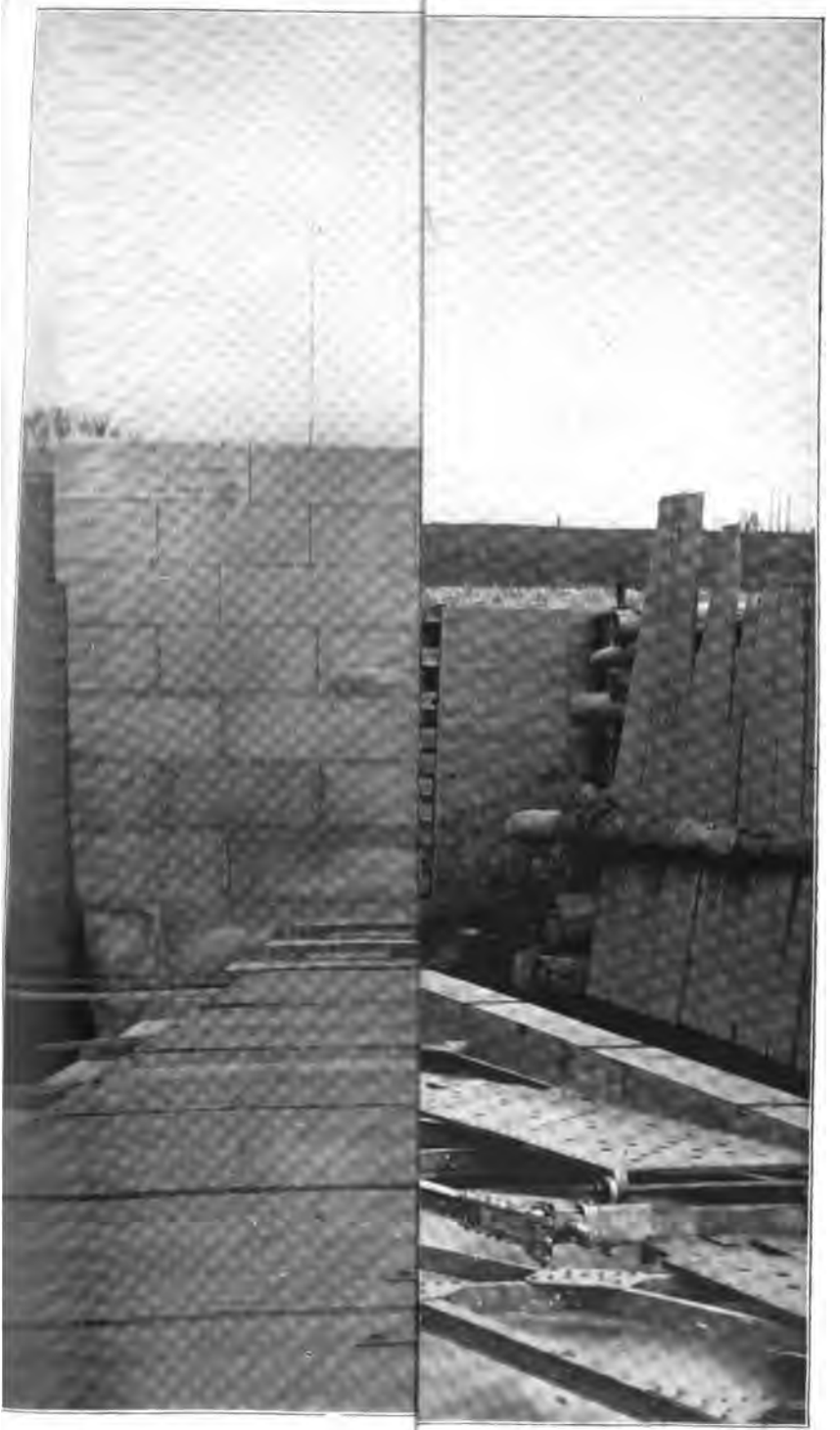

Inside the cofferdam for the weir part of the inter pier. One of the wickets is "on the swing" (*en bascule*). paced 8 feet apart.

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Showing the weir part of the dam (from the center pie he wickets and service bridge standing.

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LOC

View inside the cofferdam for the weir part of th ation in progress. Also excavating the "stop-off ditch' in the hardpan to form part lay—from 18 to 24 feet below extreme low-water mark.

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LOCK

View inside the cofferdam for the weir part of the da[illegible] core between them, for the foundation of the weir. The sheet piling, driven to make the e[illegible] of this dam rest on hardpan—an indurated clay—from 18 to 24 feet below extreme low water [illegible], etc., shown in the distance.

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LOCK A

View inside the cofferdam for the weir part of the dam ... core between them, for the foundation of the weir. The sheet piling, driven to make the exc... of this dam rest on hardpan—an indurated clay—from 18 to 24 feet below extreme low water ... etc., shown in the distance.

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Abstract of proposals for furnishing three service boats for use on Great Kanawha River, W. Va., received in response to circular letter dated February 26, 1898, and opened at Charleston, W. Va., March 12, 1898, by Addison M. Scott, Assistant Engineer, for Maj. William H. Bixby, Corps of Engineers.

No.	Name of bidder.	Three service boats.	
		Price bid each.	Amount.
1	The Enterprise Marine Dock Co	$542.00	$1,626.00
2	Calderwood & Hanna	410.00	1,230.00
3	Victor Tevebaut & Dock Co	500.00	1,500.00
4	J. R. Thayer	435.00	1,305.00
5	The Smyth & Mumford Contracting Co	554.75	1,664.25

a Recommended for acceptance.

Abstract of proposals for furnishing chains and clevises for movable dams on Great Kanawha River, received in response to advertisement dated November 20, 1897, and opened at Charleston, W. Va., December 20, 1897, by Addison M. Scott, Assistant Engineer, for Maj. William H. Bixby, Corps of Engineers.

No.	Name of bidder.	Chain ¾ inch, approximate quantity (59,200 pounds) per pound.	Chain ⅞ inch, approximate quantity (6,890 pounds) per pound.	Clevises for ¾-inch chain, approximate quantity (1,640 pounds) per pound.	Clevises for ⅞-inch chain, approximate quantity (210 pounds) per pound.	Total of bid.
		Cents.	Cents.	Cents.	Cents.	
1	The Tredegar Co	3½	3½	3½	3½	$1,563.25
2	N. S. Bergen	6¾	6¾	6¾	6¾	3,223.00
3	The J. B. Carr Co	12	12	12	12	5,772.00
4	Henry B. Newhall	2.44	3.19	6.6	8.8	1,300.60
5	James McKay & Co	3.99	3.89	3.99	3.89	1,919.19
6	M. M. Buck Manufacturing Co	9½	9½	9½	9½	4,569.50
7	The West End Rolling Mill Co	5.6	5.98	5.6	8.98	2,953.58
8	Thompson C. Gill & Co	5.89	5.89	5.89	5.89	2,833.00

a Recommended for acceptance.

Abstract of contracts for improving Great Kanawha River, West Virginia, in force during the fiscal year ending June 30, 1898.

Contractor.	Nature of contract.	Date.	To expire.
Zimmerman, Truax & Sherman.	Building lock and dam No. 9	May 23, 1893	a Dec. 31, 1898
Do	Building lock and dam No. 10	June 5, 1893	b Do.
Thos. Mumford	Building lock and dam No. 11	June 1, 1893	c Do.
Henry B. Newhall	Chains and clevises	Jan. 20, 1898	d May 14, 1898
Calderwood & Hanna	3 service boats	Apr. 6, 1898	e June 10, 1898

a Extended to June 1, 1898; completed April, 1898.
b Extended to June 1, 1898; completed March, 1898.
c Extended to September 30, 1898.
d Extended to May 20, 1898; completed May, 1898.
e Completed May, 1898.

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1898.

MAJOR: I have the honor to submit the following report on improving Great Kanawha River, West Virginia, for the fiscal year ending June 30, 1898.

In regard to the original condition of the Great Kanawha River as to depth and general availability for purposes of navigation and commerce, together with a summary of project and work accomplished, reference may be made to the Report of Chief of Engineers for 1897, Part I, page 381; also Report of Chief of Engineers for 1892, Part III, pages 2053 and following.

The principal work during the year has been at continuing the construction of

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Abstract of proposals for furnishing three service boats for use on Great Kanawha River, W. Va., received in response to circular letter dated February 26, 1898, and opened at Charleston, W. Va., March 10, 1898, by Addison M. Scott, Assistant Engineer, for Maj. William H. Bixby, Corps of Engineers.

No.	Name of builder.	Three service boats.	
		Price bid each.	Amount.
1	The Enterprise Marine Dock Co	$542.00	$1,626.00
2	Calderwood & Hanna *a*	410.00	1,230.00
3	Victor Towboat & Dock Co	560.09	1,680.27
4	J. E. Thayer	439.00	1,317.00
5	The Smyth & Munford Contracting Co	554.75	1,664.25

a Recommended for acceptance.

Abstract of proposals for furnishing chains and clevises for movable dams on Great Kanawa River, received in response to advertisement dated November 20, 1897, and opened at Charleston, W. Va, December 20, 1897, by Addison M. Scott, Assistant Engineer, for Maj. William H. Bixby, Corps of Engineers.

No.	Name of bidder.	Chain $\frac{1}{2}$ inch, approximate quantity (39,360 pounds) per pound.	Chain $\frac{7}{8}$ inch, approximate quantity (6,890 pounds) per pound.	Clevises for $\frac{1}{2}$-inch chain, approximate quantity (1,640 pounds) per pound.	Clevises for $\frac{7}{8}$-inch chain, approximate quantity (210 pounds) per pound.	Total of bid.
		Cents.	*Cents.*	*Cents.*	*Cents.*	
1	The Tredegar Co	3½	3½	3½	3½	$1,563.25
2	N. S. Burlew	6¾	6¾	6¾	6¾	3,233.00
3	The J. B. Carr Co	12	12	12	12	5,772.00
4	Henry B. Newhall *a*	2.44	3.10	6.6	8.8	1,300.69
5	James McKay & Co	3.99	3.99	3.99	3.99	1,919.19
6	M. M. Buck Manufacturing Co	9½	9½	9½	9½	4,569.50
7	The West End Rolling Mill Co	5.6	8.98	5.6	8.98	2,933.58
8	Thompson C. Gill & Co	5.89	5.89	5.89	5.89	2,833.09

a Recommended for acceptance.

Abstract of contracts for improving Great Kanawha River, West Virginia, in force during the fiscal year ending June 30, 1898.

Contractor.	Nature of contract.	Date.	To expire.
Zimmerman, Truax & Sheridan.	Building lock and dam No. 9	May 23, 1893	*a* Dec. 31, 1896
....Do	Building lock and dam No. 10	June 5, 1893	*b* Do.
Thos. Munford	Building lock and dam No. 11	June 1, 1893	*c* Do.
Henry B. Newhall	Chains and clevises	Jan. 20, 1898	*d* May 14, 1898
Calderwood & Hanna	3 service boats	Apr. 8, 1898	*e* June 10, 1898

a Extended to June 1, 1898; completed April, 1898.
b Extended to June 1, 1898; completed March, 1898.
c Extended to September 30, 1898.
d Extended to May 29, 1898; completed May, 1898.
e Completed May, 1898.

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1898.

MAJOR: I have the honor to submit the following report on improving Great Kanawha River, West Virginia, for the fiscal year ending June 30, 1898.

In regard to the original condition of the Great Kanawha River as to depth and general availability for purposes of navigation and commerce, together with a summary of project and work accomplished, reference may be made to the Report of Chief of Engineers for 1897, Part I, page 381; also Report of Chief of Engineers for 1892, Part III, pages 2053 and following.

The principal work during the year has been at continuing the construction of

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locks and movable dams Nos. 9, 10, and 11, the last three of the project required to complete the slack-water improvement to the mouth of the river.

Locks and dams 9 and 10 have been practically completed and No. 11 nearly so during the year.

LOCK AND DAM NO. 9.

[For movable dam 25 miles from mouth of river and 33 below Charleston.]

Contract for foundations and masonry.—Work on this contract with Zimmerman, Truax & Sheridan was begun in June, 1893. At the beginning of the year (July 1, 1897) the masonry of the lock and center pier and the foundations for the navigation pass were finished. The permanent cribs at the head and foot of the lock had also been completed and the greater part of the earthwork and paving and part of the riprap about the lock had been put in. The cofferdam for the weir and abutment had also been built and considerable progress made inside of it on the foundations for the weir.

Work inside the cofferdam on weir foundations, shore abutment, and abutment crib was continued during the summer and fall as the stage of the river permitted and was completed in October. Operations in the cofferdam were much interfered with in July by high water, the coffer being flooded twice during the month. After August 1 there were no interruptions. The last of the concrete was placed in the core of the weir September 23 and the last piece of coping set on the abutment, completing the mortared masonry in this contract October 20.

The placing of the fixed irons on the weir sills, hurters, wicket and trestle boxes, straps, dowels, etc., was begun September 13 and completed October 8.

The foundations of the weir rest on rock (Report for 1897, Part III, p. 2571) and from top of sill run from about 9 to 12 feet in height. The complete foundation is 23 feet wide on top, and consists of an upper and lower wall, each about 4½ feet thick, filled between with concrete and puddle (the "puddle" being gravel and clay, used simply to save concrete), covered with a cut-stone coping. The main holding disks and bolts are anchored in the concrete and the sills; boxes and other fixed irons are fastened to the coping by wedge bolts. This weir is 284 feet long. It is closed by 71 Chanoine wickets, having a vertical height of 8 feet 6 inches above sill, operated, as at the other movable dams on the river, by a service bridge.

After the completion of the foundations of the weir the movable parts—wickets, horses and props, and service-bridge trestles—were put in place by hired labor, the contractor's plant, derricks, boats, etc., being used for this in accordance with contract.

After completion of work inside the weir and abutment cofferdam the work remaining to be done on this contract consisted principally in finishing up the grading and riprapping of the banks back of and below the works on both sides of the river, removing the weir cofferdam, and cleaning up the grounds. This was in progress during the fall, and also during the winter and early spring, as the weather and stages of the river permitted.

Work on this contract was completed May 10.

The items of work done on this contract during the year, with contract prices and the totals of quantities and payments under it, are given in the following table:

Lock and Dam No. 9.

Kind of work and material.	Price.	Done after July 1, 1897.		Total in contract.	
		Quantities.	Cost.	Quantities.	Cost.
Grubbing and clearing, complete	$500.00	40 per cent.	$200.00	Complete.	$500.00
Crib logs in cofferdam, linear feet	.17	2,939	499.63	104,497	17,764.49
Sheathing, feet B. M.	25.00	9,551	238.78	95,491	2,387.28
Cofferdam fillings, cubic yards	.65	25	16.25	15,040	9,776.00
Excavation, do	.80	4,316	3,452.80	39,566	31,652.80
Rock excavation, do	2.00	35.16	70.32	381.16	762.32
Embankment, do	.55	3,790	2,089.45	8,227	4,524.85
Puddling, do	2.00	621.25	1,242.50	787.25	1,574.50
Concrete, do	6.75	444.20	2,998.35	1,981.20	13,373.10
Backing masonry, do	9.00	229.46	2,065.14	5,245.46	47,209.14
Rock-face masonry, do	11.00	449.40	4,943.40	2,663.40	29,297.40
Pointed-face masonry, do	13.00	56.21	730.73	2,075.21	26,977.73
Cut-stone masonry, do	18.00	28	504.00	482	8,676.00
Sills, do	17.00	158.52	2,694.84	534.52	9,086.84
Quoins, do	24.00	.08	1.92	70.08	1,681.92
Coping, do	18.00	210.40	3,787.20	856.40	15,415.20
Stone filling, do	2.00	1,653	3,306.00	3,953	7,906.00
Riprap, hand-placed, do	3.00	2,222	6,666.00	3,124	9,372.00
Paving, do	5.00	67	335.00	865	4,325.00
Timber in permanent construction, feet B. M.	40.00	33,892	1,355.68	158,870	6,354.80
Bolt holes in masonry, linear feet	.30	2,223	666.90	5,465	1,639.50
Total cost			37,864.89		250,256.87

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Hired labor at No. 9, lock gates, wickets, etc.—The lock gates at No. 9 were completed ready to launch early in July. They were left on top of the bank until December (the force being employed meanwhile at building gates and wickets at locks 10 and 11), when they were launched, raised, and hung. The weir wickets were completed (panel plank put in) and, as noted above, put in place along with the movable irons of the weir in October.

Work at putting the lock and dam in order for operation was in progress during May and June (after the completion of the contract for foundations and masonry) when the stages of the river would permit. The lock gates were fitted up with capstans, spars, valve connections, etc., the foundations of the navigation pass and gate recesses cleaned of deposit, panels put in the pass wickets, and the bridge aprons and trestle and wicket chains put on.

The dam was regularly raised for the first time June 25. The lock and dam will be considered in regular operation on July 1.

Three additional houses for lock hands, a blacksmith shop, drum house, a tramway from lock wall to drum house, fences, etc., have yet to be built at this site before the work is finished.

For further description of lock and dam No. 9 reference may be made to Report of Chief of Engineers for 1893 (Part III, p. 2588) and subsequent reports on the work in the Annual Reports of the Chief of Engineers.

LOCK AND DAM NO. 10.

[For movable dam 19 miles from mouth of river and 39 below Charleston.]

Contract for foundations and masonry.—Work on this contract with Zimmerman, Truax & Sheridan was begun in July, 1893. At the beginning of the year (July 1, 1897) the masonry of the lock and center pier and the foundations for the navigation pass were finished. The permanent cribs above and below the lock had been completed, and the greater part of the earthwork, paving, and part of the riprap back of and about the lock had been finished. The cofferdam for the weir and abutment had also been built and a small beginning made inside the coffer on the foundations for the weir.

Work inside the cofferdam on weir foundations, shore abutment, and abutment crib was continued when the stage of the river permitted. But little was accomplished in the river in July, owing to high water. After that the conditions were favorable and the contractor's work inside the cofferdam was finished the last of September.

The masonry of the weir was completed September 11, and the last piece of coping on the abutment, completing the mortared masonry in the contract, was set on the 18th. The retaining crib below the abutment was completed September 13. The placing of the fixed irons, wicket sills, hurters, horses and props, boxes, straps, etc., was finished September 28 and the cushion blocks and guard sill on the 30th.

The foundations of this weir are, from top of sill, from 6.2 feet to 8.9 feet in height. They rest on rock from 4 to 6.7 feet below low-water mark. As shown in former annual reports, the bed rock at No. 10 is considerably higher with reference to low water than at any other site on the river, a condition effecting a considerable saving in quantities and cost of the work.

Except in heights of walls, due to difference in elevation of bed rock and the absence of "puddle" in the core (concrete only being used in the core at 10), the weir of Dam No. 10 is of the same dimensions and construction as described above for No. 9.

After the foundations were completed and the fixed irons placed the movable parts of the weir, consisting of horses, props, wickets, and service-bridge trestles, were put in place by hired labor, the cofferdam and contractor's plant being used for this in accordance with contract.

After the completion of work inside the weir and abutment cofferdam the work remaining to be done on the contract consisted in removing the cofferdam, completing grading and riprapping the banks about the works, and cleaning up the premises. This was carried on during the fall and winter as the weather and stage of the river permitted, and work on the contract completed March 7.

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The items of work done on the contract during the year, with contract prices and the totals of quantities and payments made under it, are shown in the following table:

Lock and Dam No. 10.

Kind of work and material.	Price.	Done after July 1, 1897.		Totals in contract.	
		Quantities.	Cost.	Quantities.	Cost.
Grubbing and clearing complete	$500.00	40 per cent.	$200.00	Complete.	$500.00
Crib logs in cofferdam, linear feet	.20	1,203	240.60	88,013	17,602.60
Sheathing, feet B. M.	25.00	12,782	319.55	87,182	2,179.55
Cofferdam filling, cubic yards	1.00			12,281	12,281.00
Excavation, do	.80	10,520	8,416.00	34,030	27,224.00
Rock excavation, do	1.50	266	399.00	1,696	2,544.00
Embankment, do	.70	1,767	1,236.90	8,287	5,800.90
Puddling, do	2.00	76	152.00	294	588.00
Concrete, do	7.00	710	4,970.00	1,281	8,967.00
Backing masonry, do	9.00	170.26	1,532.34	4,119.26	37,073.34
Rock face masonry, do	12.00	362.16	4,345.92	1,757.16	21,085.92
Pointed face masonry, do	14.00	50.10	701.40	2,061.10	28,855.40
Cut stone masonry, do	19.00	33.66	639.54	469.66	8,923.54
Sills, do	19.00	156.54	2,974.26	534.54	10,156.26
Quoins, do	24.00	.08	1.92	70.08	1,681.92
Coping, do	19.00	208.10	3,953.90	852.10	16,189.90
Stone filling, do	2.00	967	1,934.00	3,269	6,538.00
Riprap, hand-placed, do	3.00	1,406	4,218.00	2,602	7,806.00
Paving, do	5.00	78	390	744	3,720.00
Timber in permanent construction, feet B. M.	45.00	18,722	842.49	131,922	5,936.49
Bolt holes in masonry, linear feet	.35	2,229	780.15	6,549	2,292.15
Total cost			38,247.97		227,945.97

Hired labor at No. 10, lock gates, wickets, etc.—The gates for this lock were built at the site, ready to launch, between July 15 and October 8. The weir wickets were also completed (51 of them framed and ironed, and the whole 71 paneled) within that time, and, as noted above, all put in place with the movable irons in October.

Putting the lock and dam in order for operation was in progress during May and June whenever the stage of the river would permit. The launching (from the top of bank), raising, hanging, and fitting up the lock gates was begun May 6 and finished June 17, the work being much interfered with by high water. As soon as the gates were in working order, the raising and fitting up of the dam, putting panels in the pass wickets, placing the chains and aprons, and cleaning the foundations of deposits was begun and is still in progress. The most difficult part of the work, cleaning the pass foundations of stone, gravel, etc., that had accumulated during construction, has been considerably delayed by a small rise in the river. Unless further interrupted by water, the dam will be put up, and Lock and Dam No. 10 put in regular operation soon after July 1.

As at No. 9, three additional lock houses, a blacksmith shop, drum house, tramway from lock wall to drum house, fences, etc., have yet to be built at this site.

LOCK AND DAM NO. 11.

[For movable dam 1¾ miles from mouth of river, 56¼ miles below Charleston, and 88¾ from head of slackwater.]

Contract for foundations and masonry.—Work on this contract with Thomas Munford was begun in July, 1893. At the beginning of the year (July 1, 1897) the masonry of the lock and center pier and the foundations of the navigation pass were completed. The permanent cribs above and below the lock and the earthworks, paving and riprap, back of the lock and lock cribs were also finished. The cofferdam for the weir part of the dam, shore abutment, and abutment cribs was also in and nearly ready for the pumps.

Weir cofferdam, etc.—A description of the cofferdam for the weir and abutment and abutment crib was given in the last annual report. It, like all the works at this site, both permanent and temporary, was built on hardpan. This coffer is about 27 feet high, the bottom being about 17½ feet below and the top 9½ feet above low-water mark. Owing to rises in the river and bad leaks in the cofferdam, scarcely anything was accomplished toward getting in foundations until August 12. There were two rises in July that went about 8 feet over the top of the cofferdam. The first of these was very swift, the Ohio being low, and carried a large quantity of drift, over two large barge loads of which were left in and on the cofferdam. The pumping machinery and banking to the coffer were also somewhat damaged by this rise.

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The leaks in the cofferdam referred to were considerable and hard to stop. They were about the pier end, between the "bulkheads" at the ends of the center pier and the main coffer. Counter coffers of heavy piles (26 feet long, driven to hardpan), stringers, sheet piling, and puddle had finally to be built entirely around the pier ends of the cofferdam. This shut off the leaks so that it was no trouble for the pumps to keep the water down after August 12.

Excavation inside the coffer was resumed August 13 (but little had been done up to that time), and there was no interruption to the work after that until November 18, when the coffer was flooded by a rise in the river.

Weir foundations.—The foundations of the weir are in general construction like those of the navigation pass of this dam, described in Report of Chief of Engineers for 1896, Part IV, pages 2253, 2254. They are formed of two lines of timber, stone-filled cribs, with vertical backs, 12 feet apart, the 12-foot space, or the core, being filled with concrete, and the whole—cribs and core—covered with a single course of cut stone, that forms the apron of the weir. The foundation in cross section is 46 feet wide on the bottom (the bottom width of both lines of cribs being 17 feet) and 23 feet wide at neat lines of coping. The cribs have a face batter, in offsets, of 6 inches per foot and are from 17 to 20 feet high, according to elevation of bottom. From hardpan to top of weir sill the height is from 19¼ to 22¼ feet. The anchorage—cast disks and bolts—for the wickets is in the concrete core, and for the service bridge in the upper lines of cribs. The sills, boxes, and hurters are set in the coping and fastened to it by wedge bolts.

The bottoms of the cribs are at elevations 490 feet and 493 feet (tide reference), or from 20 to 17 feet below low watermark. The hardpan was leveled for the crib floors and low places in it filled with concrete. The floor timbers were set on the hardpan in cement mortar. The cribs were compactly filled by hand with loose stone. A good deal of pains was taken to guard against settlement in framing, building, and filling these cribs.

The concrete core was placed on the uneven top of the hardpan about as found, it being simply cleaned and swept and a coat of mortar put on. A "cut-off ditch" filled with concrete was made in the hardpan under the core. Not counting the ditch, the bottom of the core averages 494.25 feet reference, being from 1.25 to 4.25 feet higher than the bottom of the cribs.

After August 12 the contractor employed a large force at excavating for and putting in foundations inside the cofferdam and made excellent progress. The excavation, of which there was a large amount, was carried on for sometime night and day. The placing of concrete in weir foundations was begun August 18, and the first bed sticks for the permanent cribs were put down the same day. The cribs were completed November 12 and the last concrete put in the next day. When operations were stopped for winter, the last of November, the weir foundations were nearly completed, the most of the coping being set and part of the fixed irons placed.

Shore abutment.—Excavating for the shore abutment was begun and completed and a beginning made at placing concrete in the foundations in September. The abutment rests on hardpan, 18 feet below low water. It has a concrete base 16½ feet high, the masonry beginning two courses (3 feet) below the apron or coping of the weir. From hardpan to top of coping the abutment is 31½ feet high. Its face at masonry line is 22 feet long, with right angle wings 30 feet long, measuring from the face. Considerable trouble was anticipated in getting in the abutment foundations, owing to depth of excavation and the bank being composed largely of a very fine sand carrying a good deal of water. To save time and excavation, a row of 6-inch Wakefield piling 20 feet long (of three thicknesses of 2-inch oak plank) was first driven around three sides of the abutment site. This was braced with heavy timbers against the crib work of the weir and the excavation carried down inside. The sheet piling was driven with a 2,000-pound hammer until it bounced, and was supposed to have reached a thin bed of gravel just above the hardpan, but the excavation showed it lacked about a foot of being down. This allowed the quicksand to run under and make considerable trouble. It was finally stopped by counter sheet piling of inch boards helped with horse manure and straw, and the bottom made dry before the top of the hardpan was prepared for concrete.

The last piece of coping was set on the abutment November 18.

In addition to the usual puddle about the upper wing to prevent leakage around the abutment, a row of 6-inch tongued and grooved sheet piling was driven to hardpan and carried 20 feet back of the end of the upper wing.

Abutment crib, etc.—The retaining crib below the abutment was built (inside the cofferdam) in October. It is 67 feet long and the main part of it 19 feet high. It is on the hardpan 18 feet below low water. Below and 8 feet back of the face of the crib a double row of piles extending 63 feet farther down were driven as a support to the bank protection. The piles were 25 feet long, shod with May's patent shoes. They were driven with a 2,000-pound hammer about 3 feet into the hardpan, or to about 20 feet below low water. They are connected at the top with stringers and bolts shored to the bank under the riprap and backed with a row of sheet piling.

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Apron below weir.—In the first plans no apron was proposed below the weir, the depth to the hardpan being so great that it was considered unnecessary. As a matter of precaution it was afterwards thought advisable to build a short apron below the abutment end of the weir, that being the part most liable to scour, owing to the wickets being lowered first, and under greatest head, and kept down longest at that end. This was approved by Major Gregory and the Chief of Engineers, and the apron built by the contractor under supplemental agreement (made in July) the latter part of October. It is a timber crib apron 4 feet 3 inches high, with floor and close-laid top sheathing, filled with stone. It is 122 feet long, across the river, starting from the abutment crib, and 46 feet wide at the abutment crib, narrowing to 24 feet at the outer end. It was made as wide up and down stream as the cofferdam would permit. It rests on the hardpan 18 feet below low water. For the remainder of the distance below the dam (or from the end of the apron to the center pier) the hardpan between the foot of the foundation crib and the cofferdam, a width of about 18 feet, was well covered with large, rough stone placed with a derrick.

Work done this season, and present status.—Work in the cofferdam was suspended for the season by high water and bad weather the last of November. But little of importance was done on the contract after this, except to get out and transport to the site some stone for riprapping, until in March, when grading and riprapping on the abutment bank was resumed. This was carried on through the spring months as the weather and river permitted. It was much interrupted by high water, largely backwater from the Ohio, during April and May.

The machinery for pumping the cofferdam was put in place early in June. It was started up on the 6th, and cleaning up inside the coffer commenced on the 7th. From this until June 17, when the coffer was flooded by a rise in the river, work in the cofferdam—setting coping and fixed irons—was in progress. The last piece of coping, completing the mortared masonry of this contract, was set June 10. The pumps were started again June 26, and the placing of fixed irons, guard sills, cushion blocks, etc., was resumed on the 27th. The contractor's work inside the cofferdam was completed June 29.

The work remaining to be done on this contract is as follows: Completing the grading for and riprapping the banks below the lock and abutment; dredging for and putting in a retaining crib 120 feet long below the lock; removing the weir and abutment cofferdam, and cleaning up the grounds. It is probable that the contract will be completed in August.

The work done on this contract during the year, with prices and totals, is given in the following table:

Lock and Dam No. 11.

Kinds of work and materials.	Quantities.	Price.	Amounts.
Crib logs in cofferdam ..... linear feet..	9,331	$0.30	$2,799.30
Sheathing ..... feet B. M..	38,690	40.00	1,547.60
Cofferdam filling ..... cubic yards..	1,065	.80	852.00
Common excavation ..... do....	9,362	.80	7,489.60
Hardpan excavation ..... do....	1,930	2.00	3,860.00
Rock excavation ..... do....	7	3.00	21.00
Embankment ..... do....	1,256	.75	942.00
Puddling ..... do....	158	3.00	474.00
Concrete ..... do....	3,406	7.00	23,842.00
Backing masonry ..... do....	68	9.00	612.00
Rock-face masonry ..... do....	92	10.00	920.00
Pointed-face masonry ..... do....	50	12.50	625.00
Cut-stone masonry ..... do....	34	18.00	612.00
Sills ..... do....	200	20.00	4,000.00
Coping ..... do....	257	16.00	4,112.00
Stone filling ..... do....	6,331	1.00	6,331.00
Riprap, hand-placed ..... do....	885	2.50	2,212.50
Paving ..... do....	41	4.00	164.00
Timber in permanent construction ..... feet B. M..	515,080	40.00	20,603.20
Permanent piles ..... linear feet..	1,096	.50	548.00
Bolt holes in masonry ..... do....	2,034	.50	1,017.00
Total for work during year	.....	.....	83,584.20

Hired labor at Lock No. 11—lock gates, wickets, etc.—The gates for Lock No. 11 were built at the site by hired labor. Work on them was carried on during the winter with a small force when the weather permitted outdoor work. They were completed ready to launch May 5. From this until June 18 the force was employed on the gates, etc., at Lock 10, as reported under that head. Since June 20 the carpenter force has been at No. 11 putting down skidways, setting crabs, etc., on lock walls, preparatory to launching and raising the lock gates and putting panels in weir wickets.

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The movable parts of the weir wickets, horses and props, and bridge trestles, are now nearly all placed, having been put in on the 29th and 30th of June, after the completion of the foundations inside the cofferdam, noted above.

MISCELLANEOUS WORK.

Chains and clevises.—By agreement, dated January 20, 1898 (approved February 14), contract was entered into with Henry B. Newhall, of New York (the lowest bidder), for the chains and clevises required for the wickets and bridge trestles of Dams 9, 10, and 11, including some to be used for repairs at the other movable dams. The chain was made in Allegheny, Pa. The last of the work, completing the contract, was delivered at the locks May 22. The contract embraced 39,774 pounds of ½-inch chain (for wickets) and 6,403 pounds of $\frac{5}{8}$-inch for bridge trestles, these weights including the small clevises attached. Nearly all of the chain first made under this contract had to be condemned for failure to stand required breaking strains—15,700 pounds for ½-inch and 6,400 pounds for $\frac{5}{8}$-inch chain. It was all proved to 7,000 and 2,800 pounds, respectively. The chain condemned was made of steel. Of the ½-inch chain but few specimens stood the breaking strain. The most of them broke under 13,000 pounds, several under 10,000, and a few as low as 7,000 pounds. The breaks were all rather square fractures across the weld, generally near the end of the lap. The weld itself never gave way entirely. The steel appeared to have been injured in welding. The $\frac{5}{8}$-inch steel chain proved no better. To replace the condemned chain the contractor promptly procured some good iron and made it up from that. The iron chain stood the tests well. This experience indicates that for high-grade chain, of small sizes especially, it is advisable to prohibit the use of steel.

Service boats.—The large service boats (16 feet by 60 feet), fitted up with derricks and capstans, for operating Dams 9, 10, and 11, one for each place, were built this spring under contract with Calderwood & Hanna, and proposals for building the smaller boats (7 feet 4 inches by 40 feet) required for these three works are now being called for.

Lock houses.—Drawings and specifications for the six small frame lock houses required at Locks 9 and 10, three at each lock, were prepared. Proposals for these houses were opened June 13, and contract is to be entered into with Henry Dilcher, the lowest bidder, to furnish materials for and build them.

Dredging and crane boat work.—With the exception of a small amount of work on "operating and care," reported under that head, the Government dredge and towboat *Bee* were steadily employed during the working season at "original" work, deepening and widening the permanent towing channels. Except twenty-three days spent in September and October reducing some gravel reefs to miter sill depths between Lock 9 and Knob Shoal, the work on improving during the year was all at three places, viz: Knob Shoal (in No. 10 pool), at and near Lock No. 10, and just below Lock No. 11. In addition to work with the dredge, the crew of the towboat, assisted by some hired labor, and working mainly with the crane boat, was employed nearly all of last season in removing stone, many of which were first blasted, and snags and cutting down gravel reefs. This work was also at Knob and at or near Locks 10 and 11.

At Knob Shoal (2 miles below Lock 9) the work was mainly in widening and straightening the old "dug chute." This chute is 3,100 feet long. At the beginning of last season its available coal-barge width was only about 65 feet, and it was regarded as one of the worst places for coal tows in certain stages on the river. The side or dredged walls were wide and high, and composed of heavy gravel and large stone. The improvement proposed consists principally in entirely removing the made or dredged part of the lefthand wall and throwing the righthand or shore wall about 30 feet nearer to shore. The work accomplished last summer and fall widened the chute to 110 feet for 1,900 feet from the head, and to 90 feet for the remaining 1,200 feet of its length, and effected a great improvement. The chute will finally be made 150 feet wide, at least, throughout. In removing the left wall, work with the dredge was facilitated by handling the largest of the stone with the crane boat; they were piled on and back of the shore wall. In addition to work in the chute, the shore above was cleared of a lot of sunken trees and snags to improve the entrance to the chute.

The "dug chute" at Knob will be used exclusively at pool stage. With Dam No. 10 down, tows in "bar stages" will run, as heretofore, over the shoal outside of the chute.

At Lock No. 10 the dredging and crane-boat work consisted in removing and leveling down the old chute walls and gravel reefs, to change the towing channel to the navigation pass, and in dredging the lower approach to the lock. The work above the lock extended 3,500 feet above the navigation pass and was mostly done with the crane boat, and by men working in the water with shovels, etc., during extreme low water last fall.

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Work just below Lock 10 has been under way since May 5, when dredging was resumed this season, and is still in progress. Work on this approach is well along now to a point 1,400 feet below the lock. There is considerable work to do just below No. 10 on detached reefs and old chute walls, including "Eighteen Mile," "Emory's Dam," etc. The dredging and crane-boat work required to make miter sill depth, though not continuous, will extend about 5,600 feet below the lock.

At Lock No. 11 the work consisted in dredging off rough shore projections below the lock (these projections being about half rock, mostly so large that they had to be blasted), and in blasting and removing large submerged rocks to make miter-sill depth in the approach. These shore projections, as well as the detached rocks, were evidently from "slides" that took place years ago from the adjoining bluff. Except on the rocks, there is good water at the lower entrance of the lock and on down to the mouth of the river (not less than 6½ feet in extreme low water), and the completion of the dredging and crane-boat work, with the extension of the shore crib proposed, will put this approach in good shape.

About 4,000 cubic yards of heavy material were dredged and dumped, and 1,050 cubic yards of stone blasted, and either removed or scattered in deep water at this place. The stone were drilled and blasted under water. They were mostly large, containing from 5 to 50 cubic yards each. The work was done in October and November, and extended to a point 550 feet below the lock.

There is considerably more dredging and blasting to be done along this shore to better the approach to the lock; but the work last fall will, it is thought, enable full-draft barges to be dropped out in lowest stages to the landings near the mouth of the river without material difficulty.

The summary of material handled by the dredge during the year was as follows: Dredged material, principally heavy gravel and bowlders, 52,470 cubic yards; large stone, mostly blasted and removed by the dredge with grapple, etc., 535 cubic yards; snags, 199; with, and in connection with, the crane boat, 2,660 cubic yards of stone and 67 snags.

Results accomplished—minimum depths.—As shown by former reports, the dredging and crane boat work done and proposed is mainly with a view to deepening (to miter-sill depths) and widening the permanent towing channels at the upper ends of the pools. These made channels, though not as wide as proposed, now have an available minimum depth (in low water, with pools full) of nearly or quite 6 feet, from Mount Carbon (4 miles above Lock 2) to Lock No. 10. The dredging now in progress below Lock 10 will be done, as far as proposed at present, within the next month, so that by the time Lock and Dam No. 11 are in operation it is thought 6-foot draft barges can be carried from the No. 2 pool to the landings below Lock No. 11 in low stages. It may be found necessary to remove a few more scattering piles and stone to make 6 feet depth in recently made channels, but if so, only a little time will be required for this. In many places the channels dredged have an available low-stage depth of 6½ feet for the widths made. They are to be made 6½ feet throughout. This is necessary to accommodate the coal traffic. There are comparatively few coal barges taken out now that draw as little as 6 feet, and a great many are loaded to 6½ and upward.

In widths the dredged channels have been made from 90 to 120 feet in straight parts of the river, and from 125 to 150 feet in the bends. They are to be made from 120 to 150 feet wide in straight reaches and from 175 to 250 feet in the bends.

Assistants, inspectors, etc.—The engineering and inspecting force on construction remained about as before, up to or near the completion of the main contracts on Locks and Dams 9 and 10. Assistant Engineer Thos. E. Jeffries continued through the year as assistant and head inspector at No. 11, and Assistant Engineer Albert M. Campbell in the same capacity at No. 10 up to the completion of the masonry and foundations, and after that at No. 9 until the completion of the main contract there. After the suspension of active work on construction, last December, both were employed in this office, when not required at the locks and dams, on calculations for final estimates on contracts, finished drawings of locks and dams, etc. Assistant Engineer W. W. Venable was employed on Lock and Dam No. 9 until early in March, when he was transferred to the Ohio River improvement. R. M. Stephens and J. R. Myers, subinspectors on Locks and Dams 9 and 11, have also recently been transferred to the Ohio improvement. Geo. S. Patrick is still employed as subinspector at No. 11, and S. G. Campbell continued in that capacity at No. 10 until the completion of the contract for foundations and masonry. Asbury Stalnaker, master and pilot of the towboat, had charge of the dredging and crane boat work. J. S. Williams, master carpenter, was engaged all the year on building, launching, and hanging gates at Locks Nos. 9, 10, and 11.

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

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F F 10.

OPERATING AND CARE OF LOCKS AND DAMS ON GREAT KANAWHA RIVER, WEST VIRGINIA.

[This district was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The finished locks and dams in this stream—i. e., Nos. 2, 3, 4, 5, 6, 7, and 8—were built under the appropriation for improving Great Kanawha River, West Virginia. Their location, etc., and also that of Nos. 9, 10, and 11, now under construction in the lower part of the stream under the appropriation for improving Great Kanawha River, is shown on page 2247, Annual Report of the Chief of Engineers for 1896, Part IV.

Locking was suspended at the two fixed dams thirteen days by ice and one day by high water during the year; at No. 8 low water prevailed from August 15 to November 29, suspending navigation for everything except small local packets.

Some work was done leveling the bar outside the lower end of the locks at the fixed dams. The formation of these bars is smaller each year, and they are likely to cause but little trouble hereafter.

The five completed movable dams were successfully operated during the year without notable accident. Repairs of a minor character were made at these localities. The timbers of gates at Lock No. 4 will have to be replaced, as they have become much worn. Chains and clevises were received for repairs to wickets of dams.

But little dredging was required at the completed works. Three wrecked coal barges, 1 large stone, and 11 snags were removed, and 1,240 cubic yards of material dredged.

The amount expended during the past fiscal year in operating and caring for the finished works, and in maintaining channels originally dredged between locks under the appropriation for improving Great Kanawha River, was $23,322.19.

List of dams on the river.

No.	Distance above Point Pleasant.	Style of dam.	Completed in—	Remarks.
	Miles.			
2	84½	Fixed	1887	In operation.
3	79¼	do	1882	Do.
4	73	Movable	1880	Do.
5	67¼	do	1880	Do
6	54	do	1886	Do.
7	44	do	1893	Do.
8	36	do	1893	Do.
9	25½	do	1898	Completed.
10	18¾	do	1898	Do.
11	1¾	do		Under construction.

This work was under the efficient care of Mr. Addison M. Scott, resident engineer, whose report is herewith appended.

The following is a statement of the amounts and dates of all allotments for this work:

.....	$7,075.00	July 14, 1891	$19,453.00
.....	7,810.00	July 6, 1892	21,891.64
July 8, 1886	11,170.00	July 12, 1893	24,549.41
June 17, 1887	13,289.00	July 10, 1894	30,600.00
February 4, 1888	3,549.70	July 2, 1895	30,200.00
August 16, 1888	19,990.02	July 25, 1896	37,082.59
July 11, 1889	20,600.00	August 2, 1897	22,700.77
July 16, 1890	25,702.27		
October 9, 1890	3,400.00	Total	299,063.40

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Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Great Kanawha River, West Virginia, during the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	For what paid.	Amount.
	July, 1897.		
27	Sundry persons	Services, June	$221.40
28	.....do	.....do	188.25
29	.....do	.....do	181.37
30	.....do	.....do	352.00
31	.....do	.....do	182.13
32	.....do	.....do	183.75
33	.....do	.....do	535.00
34	Thos. W. Farley	.....do	6.00
35	A. G. Flanagan	.....do	6.00
P 36	Sundry persons	.....do	176.67
76	Campbells Creek Coal Co	Coal	9.64
77	Geo. S. Couch	.....do	10.81
78	The Kanawha Nail and Iron Co	Hardware, etc	57.97
79	Lewis, Hubbard & Co	Oil	8.83
80	Ruffner Bros	Soap, etc	10.50
81	Steamer Kanawha Belle	Freight	2.75
82	James Farley	Services	1.50
83	Annie B. Kenna, postmaster	Rent of post-office box	.50
84	H. L. Gebhart	Rent of landing	6.00
89	Western Union Telegraph Co	Telegraphing	.89
	Total		2,141.86
	August, 1897		
5	Sundry persons	Service	130.00
31	Thos. W. Farley	.....do	6.00
32	A. G. Flanagan	.....do	6.00
33	Sundry persons	.....do	178.08
34	.....do	.....do	187.00
35	.....do	.....do	352.00
36	.....do	.....do	156.07
37	.....do	.....do	222.26
38	.....do	.....do	194.66
P 39	.....do	.....do	328.67
59	Diamond Ice and Coal Co	Ice	7.86
60	W. F. Shawver & Co	Solder	3.13
78	Sundry persons	Service	245.00
	Total		2,014.65
	September, 1897.		
P 94	Pay roll	Service	367.00
97	.....do	.....do	178.33
98	.....do	.....do	216.00
99	.....do	.....do	364.58
100	.....do	.....do	352.00
101	.....do	.....do	164.07
140	S. Spencer Moore & Co	Stamps	.65
141	Goshorn & Co	Hardware	11.67
143	Loewenstein & Sons	.....do	35.30
144	The Western Union Telegraph Co	Toll on telegrams	.45
145	The Southern Bell Telephone and Telegraph Co.	Rent	5.00
146	O. A. & W. T. Thayer	Sheet packing, etc	8.70
147	Howell & Shanklin	Hose	22.50
149	Walter Walker	Services	1.50
150	The W. B. Donnally Co	Lime, brick, etc	7.25
152	J. W. Knight	Services	3.50
153	Manning, Maxwell & Moore	Drill	30.20
154	J. G. W. Tompkins	Hire of team	1.87
156	Butler Printing Co	Paper	2.00
175	Lewis, Hubbard & Co	Oil, etc	12.66
177	Diamond Ice and Coal Co	Ice	6.06
180	Thos. W. Farley	Services	6.00
181	A. G. Flanagan	.....do	6.00
P 225	Steamer T. D. Dale	Freight	1.75
226	Steamer Mountaineer	.....do	3.00
P 231	Kanawha Valley Bank	Rent, etc	62.41
233	Steamer Kanawha Belle	Freight	1.50
278	The Western Union Telegraph Co	Toll on telegrams	.47
281	Chesapeake and Ohio Railway Co	Freight	.98
	Total		1,873.35
	October, 1897.		
4	Pay roll	Service	171.84
5	.....do	.....do	213.00
6	.....do	.....do	178.00

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Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Great Kanawha River, West Virginia, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	October, 1897—Continued.		
7	Pay roll	Service	$361.00
8	....do	....do	379.34
9	....do	....do	326.67
14	N. S. Burlew	Material	35.09
29	H. Barton	Rivets	2.22
46	Geo. S. Swiney	Traveling expenses	4.75
47	O. A. & W. T. Thayer	Service and material	15.74
55	Annie B. Kenna	Rent of post-office box	.33
56	The Southern Bell Telephone and Telegraph Co.	Rent of telephone, etc	3.33
57	The Kanawha Valley Bank	Rent, etc	41.59
59	The Marmet-Smith Coal and Mining Co	Coal	1.08
67	Ruffner Bros	Rope	74.15
102	C. Whithorn	Rubber stamps	.60
110	Steamer Kanawha Belle	Freight	1.10
113	Lewis, Hubbard & Co	Oil	4.29
130	S. M. Bryan	Stone	40.32
131	Butler Printing Co	Gauge cards	2.00
139	N. S. Burlew	Hardware	2.15
149	Annie B. Kenna	Rent of post-office box	.17
159	The Southern Bell Telephone and Telegraph Co.	Rent of telephone, etc	1.67
162	Kanawha Valley Bank	Rent, etc	20.79
164	A. G. Flanagan	Services	6.00
165	Thos. W. Farley	....do	6.00
	Total		1,893.22
	November, 1897.		
51	Addison M. Scott	Traveling expenses	1.04
85	Pay roll	Service	365.04
86	....do	....do	178.00
87	....do	....do	213.00
88	....do	....do	175.00
89	....do	....do	352.00
90	....do	....do	326.67
91	Thos. W. Farley	Services	6.00
93	A. G. Flanagan	....do	6.00
153	N. N. Holt	Oil	4.00
157	Chas. F. Doss	Coal	13.00
158	William Peters	....do	12.00
	Total		1,651.75
	December, 1897.		
25	Pay roll	Service	357.00
P 26	....do	....do	348.67
27	....do	....do	184.20
28	....do	....do	364.40
29	....do	....do	368.33
32	Thomas W. Farley	Services	6.00
33	A. G. Flanagan	....do	6.00
47	The Charleston Lumber Co	Lumber	.42
48	Mohler Lumber Co	....do	21.92
49	Northwestern Manufacturing Co	Paint	21.00
50	Cincinnati Varnish Co	Asphaltum varnish	25.20
P 56	Marine Oil Co	Oil	14.84
57	J. M. Gates	Spirits turpentine	15.30
P 58	The Enterprise Dock Co	Rent of docks, etc	15.50
61	Western Union Telegraph Co	Telegraphing	1.00
62	Steamer Kanawha Belle	Freight	1.50
P 69	Lewis, Hubbard & Co	Oil	4.37
70	C. H. Slack	Coal	16.00
73	Diamond Ice and Coal Co	Ice	1.06
74	H. L. Wilson	Coal	22.50
76	Silas Morris	Hire of team	9.00
77	James West	Coal	9.00
103	Richard Cobb, jr	....do	21.25
127	O. A. & W. T. Thayer	Material and service	49.94
129	N. P. Sullivan	Lumber	8.44
135	F. L. Gary	Coal	15.75
137	Western Electric Co	Wire, etc	61.19
170	S. Spencer Moore & Co	Rubber stamps	1.20
190	G. L. Williams	Hire of team	9.00
194	J. H. Stewart	Skiffs	33.40
228	Wm. H. Bixby	Mileage	3.36
	Total		2,016.74

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Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Great Kanawha River, West Virginia, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	January, 1898.		
P 46	Lewis, Hubbard & Co	Oil	$8.50
P 58	Pay roll	Service	338.67
59	....do	....do	352.58
60	....do	....do	186.04
61	....do	....do	183.18
62	....do	....do	181.72
63	....do	....do	192.88
64	....do	....do	239.20
P 71	Armstrong-McHelvy Lead and Oil Co	Oil	17.18
92	Goldbarth & Strauss	Window shades	3.25
93	Seth T. Farley	Services	7.98
112	Thos. W. Farley	Services	6.00
113	A. G. Flanagan	....do	6.00
115	Sterrett Bros	Towels	2.84
150	A. P. Young	Lumber	22.88
160	Western Union Telegraph Co	Telegrams	.40
162	Argand Refining Co	Oil	8.14
P 165	Addison M. Scott	Traveling expenses	2.82
168	H. L. Gebhart	Rent of landing	6.00
169	Annie B. Kenna	Rent of post-office box	.50
171	Diamond Ice and Coal Co	Ice	1.30
P 190	The Robert Clarke Co	Stationery	1.80
P 191	The Marmet-Smith Coal and Mining Co	Coal	2.61
P 192	Kanawha Valley Bank	Rent, etc	62.37
	Total		1,834.93
	February, 1898.		
29	Steamer Kanawha Belle	Freight	1.50
P 39	Pay roll	Service	314.17
40	....do	....do	294.67
41	....do	....do	195.50
42	....do	....do	181.00
43	....do	....do	183.00
44	....do	....do	352.00
45	....do	....do	200.33
73	Thos. W. Farley	Services	6.00
74	A. G. Flanagan	....do	6.00
P 87	The Webb Stationery and Printing Co	Job printing	5.29
106	The Southern Bell Telephone and Telegraph Co.	Rent of telephone	9.00
113	The Standard Electric Co	Services and material	4.10
118	Abney Barnes & Co	Duck	5.94
119	J. M. Gates	Lampblack	1.08
	Total		1,760.08
	March, 1898.		
12	C. A. Marshall	Services	5.33
13	J. M. Miller	Hire of team	.70
16	Western Union Telegraph Co	Telegrams	.40
17	Henry Dilcher	Lumber	15.58
18	L. C. Gates	Tacks	1.50
26	James F. Dew	Lumber	38.00
27	The Big Kanawha and Ohio River Packet Co	Transportation	.25
28	Steamer Kanawha Belle	....do	.25
40	Pay roll	Service	352.00
41	....do	....do	372.00
42	....do	....do	189.52
43	....do	....do	484.76
45	....do	....do	12.00
P 47	....do	....do	314.17
49	James F. Dew	Lumber	20.18
P 59	The Engineering News Publishing Co	Advertising	2.00
P 68	The Dispatch Publishing Co	....do	1.50
80	Diamond Ice and Coal Co	Ice	1.20
P 81	S. Spencer Moore & Co	Stationery	16.39
P 86	Public Ledger	Advertising	2.70
90	Mohler Lumber Co	Lumber	11.82
P 91	McManamy & Cannon	Stove, etc	1.50
92	Lewis, Hubbard & Co	Oakum	17.50
94	Goshorn & Co	Oars	10.80
95	The W. B. Donnally Co	Hauling	4.00
101	W. F. Shawver & Co	Stove, tinware, etc	9.30
102	Argand Refining Co	Oil	7.98
	Total		1,873.33

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Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Great Kanawha River, West Virginia, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	April, 1898.		
29	The Charleston Lumber Co	Lumber	$125.54
P 30	C. J. Rudesill & Son	Glass and queensware, etc	24.90
47	Pay roll	Service	12.00
P 48	do	do	286.67
52	do	do	186.04
53	do	do	452.00
54	do	do	210.42
55	do	do	371.98
56	do	do	207.38
68	N. S. Burlew	Hardware	18.02
70	Western Union Telegraph Co	Telegrams	1.20
72	The Southern Bell Telephone and Telegraph Co.	Rent of telephone	9.00
	Total		1,905.15
	May, 1898.		
24	Loewenstein & Sons	Hardware	14.07
28	Annie B. Kenna	Rent of post-office box	.50
P 33	A. P. Young	Lumber	54.30
36	H. Barton	Machine supplies	2.85
47	Pay roll	Service	12.00
P 48	do	do	286.67
53	do	do	385.62
54	do	do	322.76
55	do	do	352.00
56	do	do	364.00
P 59	Addison M. Scott	Traveling expenses	1.60
62	L. E. Showen	Hire of team	1.40
73	Steamer Kanawha Belle	Freight	.50
	Total		1,798.27
	June, 1898.		
21	Pay roll	Service	352.00
22	do	do	189.08
23	do	do	187.97
24	do	do	12.00
P 25	do	do	296.67
28	do	do	379.04
29	do	do	209.61
P 49	Victor Towboat and Dock Co	Service and material	244.83
54	Argand Refining Co	Oil	4.07
P 63	The Kanawha Valley Bank	Rent, etc	62.38
76	H. Barton	Globe valve	.55
77	Diamond Ice and Coal Co	Ice	1.30
78	Andrew J. Morse & Son	Submarine divers' supplies	51.50
P 134	Henry B. Newhall	Chain and clevises	295.51
P 135	Charles Ward	Material for repairs	5.50
P 136	Elk Foundry and Machine Co	Service and material	19.31
139	Lewis, Hubbard & Co	Supplies	20.99
140	The Robert Clarke Co	Stationery	7.85
P 141	A. B. Dick Co	Typewriter supplies	5.36
162	Cincinnati Varnish Co	Asphaltum varnish	25.20
163	Ruffner Bros	Linseed oil	38.35
P 164	National Paint and Varnish Co	Paint	38.48
165	Armstrong McKelvy Lead and Oil Co	Lampblack	1.44
P 167	Argand Refining Co	Oil	3.96
P 168	S. Spencer Moore & Co	Stationery	16.50
P 186	Steamer Kanawha Belle	Freight	.50
187	Western Union Telegraph Co	Telegrams	.61
188	Lewis, Hubbard & Co	Lead, etc	85.00
189	A. H. Bryan	Traveling expenses	3.30
	Total		2,558.86

Summary of expenditures for operating and care of locks and dams on Great Kanawha River, West Virginia, for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$3,429.30
Labor	17,590.31
Fuel	133.64
Expenses	927.58
Repairs	1,241.36
Total	23,322.19

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COMMERCIAL STATISTICS.

Statement of number of tons of coal, including that manufactured into coke, shipped by river from mines on the Great Kanawha for several years named.

Fiscal year.	Tons.	Fiscal year.	Tons.	Fiscal year.	Tons.
1875	161,932	1886	714,465	1893	919,320
1876	200,962	1887	929,335	1894	1,032,840
1877	207,346	1888	804,025	1895	879,304
1881	385,148	1889	1,076,872	1896	922,000
1883	614,818	1890	966,462	1897	848,600
1884	736,843	1891	1,030,454		
1885	713,493	1892	1,071,511	1897 (calendar)	650,680

Tonnage of the Great Kanawha River for the calendar year ending December 31, 1897.

Articles.	Quantity.	Tonnage.
Coal, bushels	16,267,000	650,680
Timber, feet B. M.	17,344,000	28,906
Staves, oak, number	25,000	187
Bark and wood for tanning, cords	5,550	10,545
Hoop poles, number	344,000	860
Railroad ties, oak, do	762,000	88,583
Shingles, do	2,101,000	315
Bricks, do	173,500	434
Salt, barrels	1,660	232
Merchandise and produce in steamboats		51,260
Total		832,002

Total tonnage of the Great Kanawha River for the several years named.

Year ending June 30—	Tons.	Year ending June 30—	Tons.
1890	1,127,232	1895	1,082,342
1891	1,225,355	1896	1,162,782
1892	1,360,750	1897	1,124,843
1893	1,116,537	1897 (calendar)	832,002
1894	1,222,530		

Commerce passing each of the seven finished locks and dams in Great Kanawha River, West Virginia, during the calendar year ending December 31, 1897.

Articles.	Lock No. 2.	Lock No. 3.	Lock No. 4.	Lock No. 5.	Lock No. 6.	Lock No. 7.	Lock No. 8.
Coal, bushels	1,566,000	2,274,500	5,038,200	6,961,900	11,098,000	11,301,600	15,739,000
Coke, tons	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Lumber, etc, feet	147,500	1,791,800	1,741,400	1,886,560	5,055,350	3,599,750	5,318,000
Shingles, number	66,000	145,000	669,750	1,032,250	40,000	39,300	10,000
Bricks, do	10,600	41,300	36,720	42,490	181,000	11,000	14,200
Miscellaneous freight, tons	2,862	5,827	10,188	12,173	18,485	17,365	19,210
Steamboats, number	1,456	1,560	1,668	1,763	1,823	1,772	1,938
Coal barges, do	238	360	750	1,283	1,556	1,707	2,292
Other craft, do	34	93	84	119	130	175	214
Passengers, do	6,303	10,077	16,605	25,678	27,537	15,760	11,456
Salt, barrels	239	525	505	1,277	380	604	50
Railroad ties, number					30,950	39,225	514,900
Hoop poles, do					19,450	19,450	
Bark, cords				125	200		
Lockages, number	1,489	1,653	1,023	1,149	1,125	881	1,167

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List of stern and side-wheel boats plying on the Great Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Bee	U. S. towboat	120	22	3.2	85
Mascot *a*	U. S. launch	61	8.1	3.4	7
Goldenrod	U. S. light-house tender	150	26.5	3.7	143.58
W. F. Nesbit	Packet	200	35	6.1	576.86
Kanawha	do	185	35	4	429.07
Henry M. Stanley	do	180	32.4	5.5	293.71
Urania	do	160	28	5	213.09
Columbia	do	156	24.2	4	197.96
H. K. Bedford	do	149	27.6	4	139.68
Speedwell	do	140	25	4	149.40
Ruth	do	136.5	24.5	4.4	131.78
Kanawha Belle	do	128	24.2	4	133.50
Mountaineer	do	122	20.2	4	110.52
T. D. Dale	do	111.6	19.7	3.2	85.77
Ida Smith	do	111.6	17.9	2.6	44.14
Sip Bays	do	105.5	14.6	1.9	24.12
Claribell	do	100	18.8	2	71.48
Neptune	do	62.6	12	2.2	19.83
Genevieve	do	59.9	11.6	2.6	12.37
E. R. Andrews	Towboat	165	32.5	5.2	351.07
Otto Marmet	do	149.5	24	4.8	135.20
Convoy	do	146	26.5	3.7	170.53
William Ernst	do	140	25.2	4	197.64
Coal Bluff	do	136	24.	4.4	162.14
Mount Clare	do	134.5	25.8	4.8	191.36
D. T. Lane	do	129.6	24.1	4	146.94
G. W. Moredock	do	126.5	25.4	3.2	148.75
Gate City	do	125	25.7	4.5	109.44
Lyda	do	120	21.4	3.4	107.90
Jessie	do	120	20	3.4	68.47
Annie L	do	115.8	20.8	3.1	114.69
J. M. Bowell	do	115	23	3.8	107.91
Geo. Matheson	do	112	23	4	124.06
W. B. Calderwood	do	112	24.5	4.6	85.55
Alex. Martin	do	109.4	20	3.2	57.39
Reba Reeves	do	107	22	3.4	63.11
Ada V	do	82	18.6	2.6	23.38
Stella	do	76	16.3	2.5	20.86
G. T. Thayer	do	49	9.3	2.2	7.95
Troubadour	Show boat	93.4	18	3	61.37
Billy Martin *a*	Pump and harbor boat	89	14.3	4	28.15
Iron Duke *a*	do	88	13.5	3.7	30.63
Madge *a*	Pleasure boat	66.5	10.5	4	9.90
Veva *a*	do	26	6	3.5	3
Ruth *a*	do	25	5	4	3

a Screw propeller.

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1898.

MAJOR: I have the honor to submit the following report on operating and keeping in repair the completed works on the Great Kanawha River for the fiscal year ending June 30, 1898.

The 7 completed locks and dams continued in good working order throughout the year. As usual a good deal was done at each of the locks by the regular hands in keeping the works in repair and order. Some of the most important items of repairs are reported below.

FIXED DAMS.

Locking was suspended at the 2 fixed dams (Nos. 2 and 3) 13 days by ice and 1 day by high water during the year.

During low water last fall the stone and gravel bars below these dams, outside the lower end of the locks, were reduced to below minimum pool surface for the purpose of improving the direction of the current in the lower approaches. The stone large enough for riprap were boated ashore and the other material leveled down to a little below water surface. At No. 2 about 320 cubic yards and at No. 3 about 400 cubic yards of stone and gravel were moved.

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These bars are formed by the action of the water over the dam during floods. At No. 2, where the dam was built at the head of a shoal, they were at first high and quite extensive, and have been worked on during low water in the fall more or less every year since the lock and dam were finished in 1887. The bars form smaller each year as the original material on top of the rock is washed out, and they are likely to cause but little trouble hereafter. This reduction of the bars below the fixed dams has materially improved the direction of the current in the lock approaches, and has furnished a large quantity of cheap stone needed to repair and extend the riprapping below the works.

MOVABLE DAMS.

The 5 completed movable dams were all successfully operated during the year and without notable accident.

Locks and dams Nos. 4 and 5.—Dam No. 4 was kept up 207 days and Dam No. 5 205 days during the year, and down the remainder of the time owing to high or sufficient stages of water. The dams were raised six times and lowered six times, five of the lowerings being on account of rises in the river and one on account of ice. They were down continuously from January 2 to March 6. The dams were raised the last time in May 31 and are still up.

At No. 4 during the winter 80 cubic yards of stone were got out and hauled to the site to repair riprapping below the lock. At No. 5 the guard crib at the foot of the river wall was repaired last fall, four rounds of timber being taken off and replaced by new.

These two locks and dams (No. 5 is 9 and No. 4 15 miles above Charleston) were completed and put in operation in July, 1880, and were the first movable dams in connection with slack-water navigation built in America. The wickets on these dams (of Chanoine type throughout) are now much worn. On the weirs the wickets have had considerable repairs and some new ones have been built and placed, using the old irons. The wooden gates at No. 4, now in their nineteenth year, are also about used up. The timber part of them will soon have to be renewed. Timber for this is now at the site and partly framed.

Lock and Dam No. 6 (4 miles below Charleston, finished in 1886).—The dam was kept up 185 days during the year. It was raised and lowered four times, three of the lowerings being for rises in the river and one on account of ice. The dam was down continuously from December 21 to May 5. It was put up the last time June 1 and has been standing since that date.

Lock and Dam No. 7 (14 miles below Charleston, finished in 1893).—This dam was kept up 185 days. The maneuvers were the same as at No. 6, reported above.

Lock and Dam No. 8 (22 miles below Charleston, finished in 1893).—This dam was kept up 180 days during the year. It was raised and lowered four times, three of the lowerings being for rises and one on account of ice. The dam was down continuously from December 21 until May 5. It was raised the last time June 1 and is still up.

About 120 cubic yards of stone were reset and 25 yards of new stone added in repairing damage done by a slide to the riprap on the abutment bank.

MISCELLANEOUS WORK.

Chains for movable dams.—Two hundred and forty half-inch diameter chains, of special make and strength, with clevises attached, aggregating 11,211 pounds, were procured for repairs to wickets at the completed dams. They were included in the contract dated January 20 for wicket and trestle chains and clevises for dams 9, 10, and 11, reported under "Improving Great Kanawha River, West Virginia."

Dredging.—[The original dredging done on "Improving" is reported under that head]. But little work of this kind was required during the year in maintaining existing navigation by removing sediment and obstructions from lock approaches and made channels. That done, consisted in tearing out three wrecked and abandoned coal barges, one being just above the weir at Lock No. 4, one near the towing channel below Lock 11, and the other from the United States harbor of refuge at Point Pleasant, and in removing sediment washed into the chute at Thirteen Mile Shoal, in No. 11 pool, by high water in Thirteen Mile Creek. At the latter place 1,240 cubic yards of dredged material, 1 large stone, and 11 snags were removed from the chute.

Low water.—Navigation was suspended below Lock 8, the last completed lock and dam, for everything except small local packets, nearly all the time from August 15 to November 29 by low water.

Commerce.—The commerce passing each of the completed locks and dams and the number of lockages made for the year ending December 31, 1897, is given in connection with the Commercial statistics for the river.

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. WILLIAM H. BIXBY,
Corps of Engineers, U. S. A.

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F F 11.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

Under authority of the Chief of Engineers, dated July 6, 1896, operations were practically suspended pending the outcome of proceedings instituted by the United States attorney for the district of West Virginia for the purpose of removing the Frametown and Ashley dams, the principal obstructions in the river.

During the year the only work done was that authorized by the Chief of Engineers in the chute at Queen Shoal, 25 miles above Charleston, W. Va., in removing some obstructions and raising the dikes from 3½ to 4 feet in height for a length of 500 feet, placing the chute in good condition at a cost of $105.93.

This work has been carried on under the efficient charge of Mr. Addison M. Scott, resident engineer, whose report with special reference to the commerce of the river is herewith appended.

Money statement.

July 1, 1897, balance unexpended	$3,496.30
June 30, 1898, amount expended during fiscal year	108.73
July 1, 1898, balance unexpended	3,387.57
Amount (estimated) required for completion of existing project	69,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Appropriations.

June 18, 1878	$5,000	September 19, 1890	$2,500
June 14, 1880	5,000	July 13, 1892	2,500
March 3, 1881	5,000	August 18, 1894	2,000
August 2, 1882	2,000	June 3, 1896	2,000
August 5, 1886	1,500		
August 11, 1888	3,000	Total	30,500

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1898.

MAJOR: I have the honor to submit the following report on improving Elk River, West Virginia:

Commercial statistics for Elk River, West Virginia.

Year.	Saw logs and lumber.	Railroad ties, oak.	Staves, oak.	Hoop poles.	Hickory spokes.	Tan bark and wood.	Tonnage of timber products.
	Feet.					*Cords.*	
1883 (fiscal year)	5,200,000	100,000	898,334	.....	.....	.....	24,790
1884 (fiscal year)	5,975,000	125,000	1,122,500	.....	.....	.....	30,700
1885 (fiscal year)	5,100,000	250,000	1,433,750	.....	.....	.....	33,500
1886 (fiscal year)	15,361,000	250,000	1,845,000	.....	.....	.....	68,510
1888 (fiscal year)	15,900,000	330,000	1,210,000	.....	.....	.....	71,150
1889 (fiscal year)	15,750,000	295,000	1,600,000	500,000	350,000	.....	70,200
1890 (fiscal year)	26,650,000	330,000	1,380,000	150,000	568,000	300	89,880
1891 (fiscal year)	27,995,000	412,500	800,000	125,000	200,000	500	103,700
1892 (fiscal year)	44,400,000	380,000	1,405,000	.....	.....	240	139,800
1893 (fiscal year)	37,516,000	353,000	1,390,000	.....	.....	612	125,400
1894 (fiscal year)	21,844,000	302,000	900,000	.....	.....	800	92,630
1895 (fiscal year)	31,160,000	280,000	1,662,000	230,000	.....	1,800	112,100
1896 (fiscal year)	29,321,000	214,000	250,000	.....	.....	4,800	92,000
1897 (fiscal year)	23,945,000	287,000	.....	.....	.....	4,800	92,100
1897 (calendar year)	19,256,000	271,000	.....	.....	.....	4,800	72,707

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About 1,200 tons of miscellaneous freight (merchandise, produce, etc.) were carried by push boats and canoes during the year. In addition, about 3,750 tons of building sand were dredged from the bed of the river near Charleston and boated to adjacent landings. This, with the timber products as above, makes the total commerce for the year 77,657 tons.

In reference to new lines of transportation, there were no changes, the Charleston, Clendennin and Sutton Railroad, building through the valley, not having been extended beyond Clay Court-House during the year. This road has been in operation to Clay Court-House, 51 miles up, since 1896, and as shown in the Report of the Chief of Engineers for that year (Part IV, p. 2263) has had considerable effect in reducing important classes of river business. The continuation of this road to Sutton will no doubt still further curtail commerce by river.

As to "the extent to which commerce and navigation would be benefited by the completion of the work." As noted in last year's report, the river, with the exception of the old milldams, is in a fairly good and pretty uniform condition for rafting and driving logs in freshet stages, this now constituting nearly all the traffic. All considered, the only additional work it seems expedient for the United States to do on the Elk, for some time at least, is in the removal of the old milldams. (See Report of Chief of Engineers for 1897, Part III, pp. 2565–2566.)

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 12.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

During the year no work has been undertaken on this stream. In view of the short period each season when work could be performed economically, and of the inexpediency of dividing the work into two seasons, it was recommended by Col. Peter C. Hains, Corps of Engineers, then in charge, that the project for expending the appropriation of that year ($3,000) be postponed. This was approved by the Chief of Engineers. From information now at hand it appears that the conditions have been changed so greatly by the construction of railroads and their absorption of the river commerce that it has been considered unadvisable to continue the work hitherto done under the project on the "Roughs" and in the lower end of the river.

The funds available could probably be applied with profit on the channel in the upper river, but no recommendation can be made until an examination is made and more definite information procured.

The report of Mr. Addison M. Scott, resident engineer, regarding the commerce of the river, is herewith.

Money statement.

July 1, 1897, balance unexpended	$3,697.03
June 30, 1898, amount expended during fiscal year	34.45
July 1, 1898, balance unexpended	3,662.58
July 1, 1898, outstanding liabilities	4.50
July 1, 1898, balance available	3,658.08
Amount (estimated) required for completion of existing project	60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Appropriations.

August 11, 1888	$3,000
September 19, 1890	3,000
July 13, 1892	3,000
August 18, 1894	3,000
June 3, 1896	3,000
Total	15,000

Commercial statistics for Gauley River, West Virginia.

Year.	Saw logs.	Lumber.	Staves.	Coal.	Shingles.	Railroad ties.	Timber tonnage.	Produce.	Total from Gauley.	Merchandise to Gauley.
	Feet.	*Feet.*		*Tons.*				*Tons.*	*Tons.*	*Tons.*
1888 (fiscal)	691,800	2,535,300	177,400	.....	.....	.....	7,121	26	7,151	750
1889 (fiscal)	890,400	3,615,000	274,200	.....	.....	.....	9,491	78	9,569	1,322
1890 (fiscal)	384,800	4,452,500	.....	.....	.....	.....	9,676	90	9,766	1,985
1891 (fiscal)	384,700	4,701,300	100,000	.....	.....	.....	10,347	89	10,436	1,964
1892 (fiscal)	261,170	5,249,200	1,200,000	.....	111,000	.....	9,527	103	9,630	3,083
1893 (fiscal)	302,000	5,470,000	113,700	.....	75,000	.....	9,457	114	9,571	2,405
1894 (fiscal)	523,000	4,765,000	488,000	525	.....	.....	8,506	213	9,244	2,398
1895 (fiscal)	2,000,000	5,000,000	1,000,000	2,000	50,000	.....	.....	.....	19,060	4,500
1896 (fiscal)	500,000	7,000,000	1,585,400	.....	.....	15,000	.....	.....	19,110	1,500
1897 (fiscal)	500,000	.....	.....	.....	.....	.....	830	.....	.....	.....
1897 (calendar)	.....	15,000,000	.....	.....	.....	.....	25,000	.....	.....	.....

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1898.

MAJOR: The only commerce on Gauley River during the calendar year ending December 31, 1897, consisted of some logs floated a distance of from 11 to 28 miles to the large mill of the Gauley River Lumber Company, at Camden-on-Gauley, at the terminus of the West Virginia and Pittsburg Railroad, about 64 miles from the mouth of the river. The logs were cut on Williams River (this stream comes in 11 miles above Camden) and on the main stream. About 15,000,000 feet of lumber, equaling about 25,000 tons, were so cut and floated.

This lumbering business on the upper river has been in operation since the railroad was finished to Camden, about 1890, but has never been included in the United States Engineer reports of commercial statistics of this river, they having been confined to the lower 12 miles of the river or from the foot of the "Roughs."

The entire river business in the lower end of the stream, constituting all of that heretofore reported, has been practically stopped by the extension of the Chesapeake and Ohio Railroad up the river to the mouth of Twenty Mile Creek. Nothing was shipped on this part of the river during the last year. In this connection a copy of a letter from Mr. F. O. Havener, an intelligent lumberman, dated July 20, 1897, is inclosed. Mr. Havener's statements are entirely confirmed by other parties acquainted with the river.

The West Virginia and Pittsburg Railroad was built principally to develop the timber and coal on the upper Gauley and tributaries. It is to be continued on down the river for the same purpose, and will finally, it is thought, connect with the Chesapeake and Ohio.

In view of the changed conditions since the adoption of the project in 1888 (Report of Chief of Engineers for 1897, Part I, p. 380) and general information about the river, the advisability of continuing work under the project, by blasting down the large bowlders on the Roughs, is extremely doubtful. According to information at hand, no logs would ever be floated through the Roughs after the proposed channel was blasted through the bowlders except those that escaped from the mills and booms on the upper river.

All considered, it appears advisable to withhold further expenditure on this project until more exact information is obtained.

Respectfully submitted.

ADDISON M. SCOTT,
Resident Engineer.

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

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F F 13.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The balance unexpended was furnished by the act of Congress of August 5, 1886, with the stipulation: "Continuing improvement between the lead mines, in Wythe County, and the mouth of Wilsons Creek, in Grayson County." By letter dated April 17, 1891, it was reported to the Chief of Engineers that any further improvement of that portion of the stream was wholly unnecessary, on account of changed conditions in late years. The Chief of Engineers, under date of April 23, 1891, stated that the Secretary of War had decided that the unexpended balance should be withheld from expenditure until further action is taken by Congress. Nothing has, therefore, been done toward improving the stream since that time.

Money statement.

July 1, 1897, balance unexpended	$2,308.94
July 1, 1898, balance unexpended	2,308.94

Appropriations.

August 14, 1876	$15,000	June 14, 1880	$24,000
June 18, 1878	15,000	August 2, 1882	12,000
March 3, 1879	12,000		
March 3, 1881	24,000	Total	112,000
August 5, 1886	10,000		

F F 14.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The approved project for the improvement of this river, adopted in 1878, provides for obtaining a clear channel for a distance of 122 miles upstream from its mouth, with a width of from 30 to 50 feet, and with a least depth of 18 inches, during five months of the year, the same to be obtained by the removal of obstructions, such as logs, snags, stumps, rocks, and overhanging trees, and by the construction of low stone dikes at shoals so as to concentrate and increase the depth of water at such points.

The characteristics of the stream are described in the Annual Reports of the Chief of Engineers for 1875, pp. 747–755; 1895, pp. 2517–2520, and 1896, pp. 2324, 2325.

Funds being practically exhausted at the beginning of the year, the only work done was the removal of a few snags and about 500 cubic yards rock composing a low dike at Four-Mile Shoal, which had not proved successful. Renewed complaints were made during the year as to the two milldams—Peck's, 7 miles below Logan Courthouse, and Lambert's,

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19 miles below Peck's—previously reported as serious obstructions; but the parties have been warned of the illegality of such structures, and have promised to open and preserve the necessary channelway. Public notices have also been posted warning all parties not to allow their log rafts to obstruct steamboat navigation in the lower end of the river.

Plans for the construction of a bridge across the Guyandotte River at Salt Rock, in Cabell County, W. Va., were approved by the Secretary of War under date of November 1, 1897.

Further details are given in the report of Mr. B. F. Thomas, resident engineer, herewith:

Money statement.

July 1, 1897, balance unexpended	$81.21
June 30, 1898, amount expended during fiscal year	42.75
July 1, 1898, balance unexpended	38.46
Amount that can be profitably expended in fiscal year ending June 30, 1900 (all of which is for maintenance)	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

June 18, 1878	$2,000	August 11, 1888	$2,000
March 3, 1879	1,000	September 19, 1890	2,000
June 14, 1880	2,000	July 13, 1892	2,000
March 3, 1881	3,500	August 18, 1894	2,000
August 2, 1882	2,000	June 3, 1896	1,000
July 5, 1884	2,000	Total	21,500

Commercial statistics for Guyandotte River, West Virginia.

Year.	Cross-ties.	Timber.	Miscellaneous.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1891 (fiscal year)	.....	60,000	1,128	61,128
1892 (fiscal year)	12,500	90,000	1,300	103,800
1893 (fiscal year)	60,000	120,940	1,310	182,250
1894 (fiscal year)	40,000	100,000	1,221	141,221
1895 (fiscal year)	35,000	210,000	2,400	247,400
1896 (fiscal year)	40,000	160,000	2,000	202,000
1897 (fiscal year)	50,000	90,000	3,300	143,300
1897 (calendar year)	80,000	100,000	10,000	190,000

Passengers, calendar year 1897, number 1,200.

The present plan of improvement will not add to the commerce, but only render it possible and safe.

List of boats plying the Guyandotte River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Jennie George	Side-wheel	93	14	2.5	87.41
J. T. Hustler	do	75	16	2.2	16.68
Favorite	do	103	14.8	2.5	43.64
Guyandotte	do	104	16	2.8	43.83

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REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa., June 30, 1898.

MAJOR: I have the honor to report upon the improvement of the Guyandotte River, West Virginia, for the fiscal year ending June 30, 1898.

Characteristics.—The Guyandotte River has its source in the southwestern part of West Virginia, and flows somewhat northwestwardly to its junction with the Ohio at a point some 12 miles above the mouth of the Big Sandy. The State of Virginia built six locks and dams of inferior character in this stream many years ago, which went rapidly to decay and became obstructions to navigation. The upper portion has been for years and is at present obstructed by two milldams—Peck's, 7 miles below Logan Courthouse, and Lambert's, 19 miles below Peck's—which render that part of the stream unfit for navigation except upon extra good stages of water. Until these obstructing dams have been removed, or greatly modified in construction, the full benefit of the improvements made by the Government will not be realized.

Original condition.—Previous to the commencement of improvements on this river the channel was badly obstructed by snags, trees, rocks, etc., and the shoals were irregular and difficult of ascent or descent, owing to the crookedness of the chutes, or even the absence of chutes; the bends were rendered unsafe at certain stages because of projecting rocks of immense size, off which it was often impossible to keep timber rafts; overhanging trees added to the danger of steamboat navigation, and, taken altogether, it was always at some considerable risk that navigation was carried on, particularly after nightfall. Even at a good stage of water navigation was unsafe on account of the liability to run onto hidden obstructions. The maximum width of the channel did not exceed 30 feet, with a mean low-water depth of 1 foot. While the river in that condition was not even a fairly good waterway, yet it was utilized as the best means available, there being no railroads in that section at that time.

Plan of improvement.—The project for the improvement of this stream, adopted in 1878, provides for removing snags, rocks, overhanging trees, and forming low wing dams of loose stone at shoal places, to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push-boat, and raft navigation. The general plan of carrying on the work adopted has been to send out during the low-water season small, light-draft push boats, with limited accommodations for a crew of from 12 to 25 men, and for storing sufficient explosives, tools, etc. A simple hand crab is provided for use in pulling the boats over shoal places and for occasionally removing a snag or tree.

The removal of snags, trees, stumps, etc., is accomplished with dynamite, generally, but as the water is usually at its lowest, this can frequently be done with axes. All bowlders and loose stones are removed from the chutes in the shoals and piled up alongside in ridges called walls, the purpose of which is to confine the water. These walls have connection with the bank, and at a steamboat stage are generally submerged to such an extent as not to be in the way.

Results and advantages.—Work under the project has been continued from time to time with small appropriations, and the river has been brought to almost as good navigable condition as is possible without slack-water improvement. The steamboat channel has been kept clear of obstructions and the walls of the push-boat chutes have been kept in repair. The shoals have been cleaned, chutes straightened, and the water confined. At mean low water boats drawing 20 inches have found no difficulty in making their trips. In extreme low water only push boats having a draft of less than 1 foot have been successful.

Operations during the past fiscal year.—The funds being practically exhausted, but little work has been done.

The work formerly done at Four Mile Shoal was not successful, and it was found necessary to remove the old wall, containing 445 cubic yards of loose rock. Four snags were also removed from the chute and a tree from the bar. The removal of the wall rendered the shoal passable.

The cost of the work done was $42.75.

Work required to complete and maintain the existing project.—The most important work required is the removal of Peck's and Lambert's dams, as their existence to a certain extent nullifies all work done below them. So long as these dams are permitted to remain obstructions, the only work advisable is the maintenance of as good chutes as practicable below Logan Courthouse, by keeping the shoals clean and directing and confining the current.

Operations contemplated for the fiscal year ending June 30, 1899.—Should there be an appropriation for this river it is proposed to expend it in the maintenance of the

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work heretofore done and in the removal of new obstructions on the 80 miles lying below Logan Courthouse. One thousand dollars will be sufficient for this purpose.

Respectfully submitted.

B. F. THOMAS,
Resident Engineer.

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 15.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The lock and movable dam at Louisa having been completed at the end of the last fiscal year, little beyond the grading and fencing of Government land and protection work remained to be done.

During the year the grounds on the Kentucky and West Virginia sides of the river were graded, sodded, and sown with grass seed, a new fence built around them, and ditches and culverts made at suitable points.

The bank below the abutment has, by the placing of 445 cubic yards of broken stone, been protected against the erosion caused by lowering the dam while the water below is low. It is probable that more protection work will be required.

A leak developed around the abutment, caused, it is believed, by muskrats following the old cofferdam timbers, and additional protection became necessary and was given by placing 375 cubic yards of stone and 280 cubic yards of clay above and behind the abutment and building a crib immediately above it. Three thousand five hundred feet B. M. of timber was thus used. The leak was lessened but not stopped, and it was found necessary to replace the clay, which was gradually washing out, with fine broken stone. While the work done may not stop the leak, it will prevent further washing and encroaching on the bank below.

Considerable work of a minor character was done.

There still remains some unfinished work, which has been delayed, awaiting the outcome of the leak at the abutment. An additional lock house is also desirable at this locality to provide a house for each lock tender.

An estimate of cost and full report on the further improvement of this stream by locks and dams was submitted by me under date of April 27, 1898, printed as H. Doc. No. 456, Fifty-fifth Congress, second session.

Accompanying this report are 15 photographs of the dam, which, taken in connection with those shown in the Annual Report for 1897, complete the illustration of the construction and operation, etc., of this dam. As this needle dam is the only one of its kind in the United States and is the highest and tightest against leakage of its kind anywhere in the world, these photographs are of special interest, and it is hoped that all may be printed.

Detailed information of the work done during the past season is given in the report of Mr. B. F. Thomas, resident engineer, herewith, under whose careful and efficient supervision this work has been carried

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on. There is also herewith a statement prepared by him as to the first year's experience with this movable dam.

Money statement.

July 1, 1897, balance unexpended	$6,336.37
June 30, 1898, amount expended during fiscal year	4,555.13
July 1, 1898, balance unexpended	1,781.24
July 1, 1898, outstanding liabilities	69.48
July 1, 1898, balance available	1,711.76
Amount that can be profitably expended in fiscal year ending June 30, 1900 (all of which is for maintenance)	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

July 18, 1878	$12,000	August 11, 1888	$31,500
March 3, 1879	12,000	September 19, 1890	31,000
June 14, 1880	50,000	July 13, 1892	50,000
March 3, 1881	46,000	August 18, 1894	40,000
August 2, 1882	15,000	June 3, 1896	30,000
July 5, 1884	40,000		
August 5, 1886	22,500	Total	380,000

Commercial statistics for fiscal year ending June 30, 1897, and prior years, Big Sandy River, West Virginia and Kentucky.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Timber	208,491	225,000	300,050	331,570	200,000	425,000	313,332	255,000
Hides	75	50	95					
Leather	34	30	4	6				
Lumber	3,000	3,000	60	650	400	500	370	300
Produce	2,511	3,000	250	1,755	2,000	3,000	2,360	5,000
Live stock	495	500	150	1,190	800	1,360	1,280	1,400
Spokes	750	2,200	4,080	530	100	50	100	
Staves	7,000	1,050	5,260	1,803	1,500	1,000	480	1,000
Tan bark	9,831	10,000	28,950	1,950	1,000	800	1,000	800
Ties	15,000	10,000	99,625	68,750	40,000	32,100	51,100	48,000
Grain	510	489						500
Wool	11	15	7	7				
Miscellaneous	19,000	21,069	16,050	55,914	50,500	80,000	100,000	100,000
Passengers	1,874	900	1,400	2,503	1,500	2,100	1,360	2,500
Total	268,582	277,303	455,926	466,723	297,800	545,910	471,382	414,500

Commercial statistics for calendar year ending December 31, 1897.

Timber	tons	250,000
Ties	do	50,000
Staves	do	1,200
Tan bark	do	700
Miscellaneous	do	105,000
Total	do	406,900
Passengers	number	20,000

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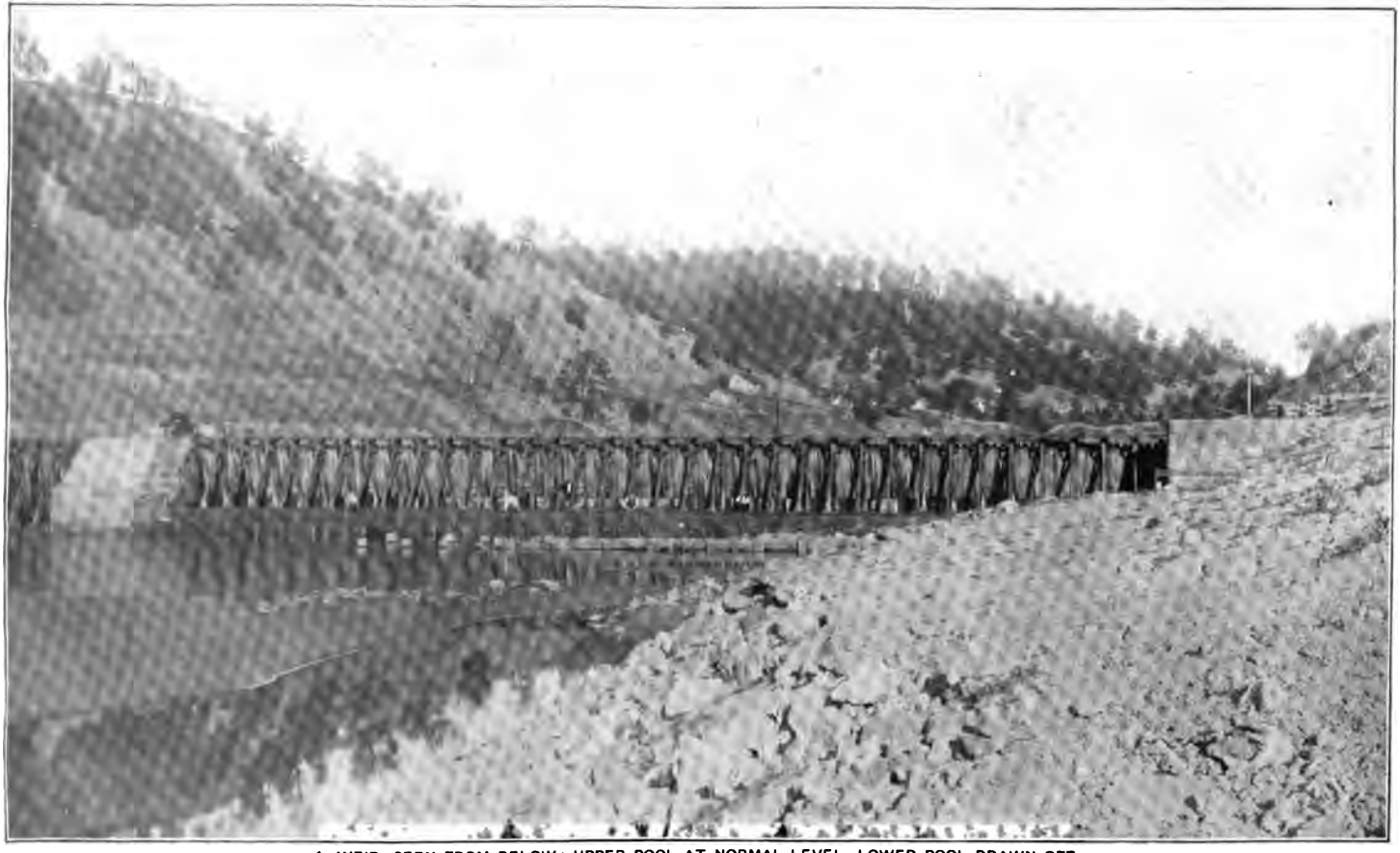
NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.



1. WEIR, SEEN FROM BELOW; UPPER POOL AT NORMAL LEVEL, LOWER POOL DRAWN OFF.

(Weir 140 feet long, of needles 12 inches wide, 8.25 feet long, 2.5 inches thick at top and 3.5 inches thick at bottom, holding back water, October 4, 1897, to 7 feet height above weir sill, with total leakage of only 1 gallon in 13.5 seconds, or 0.01 cubic foot per second.)

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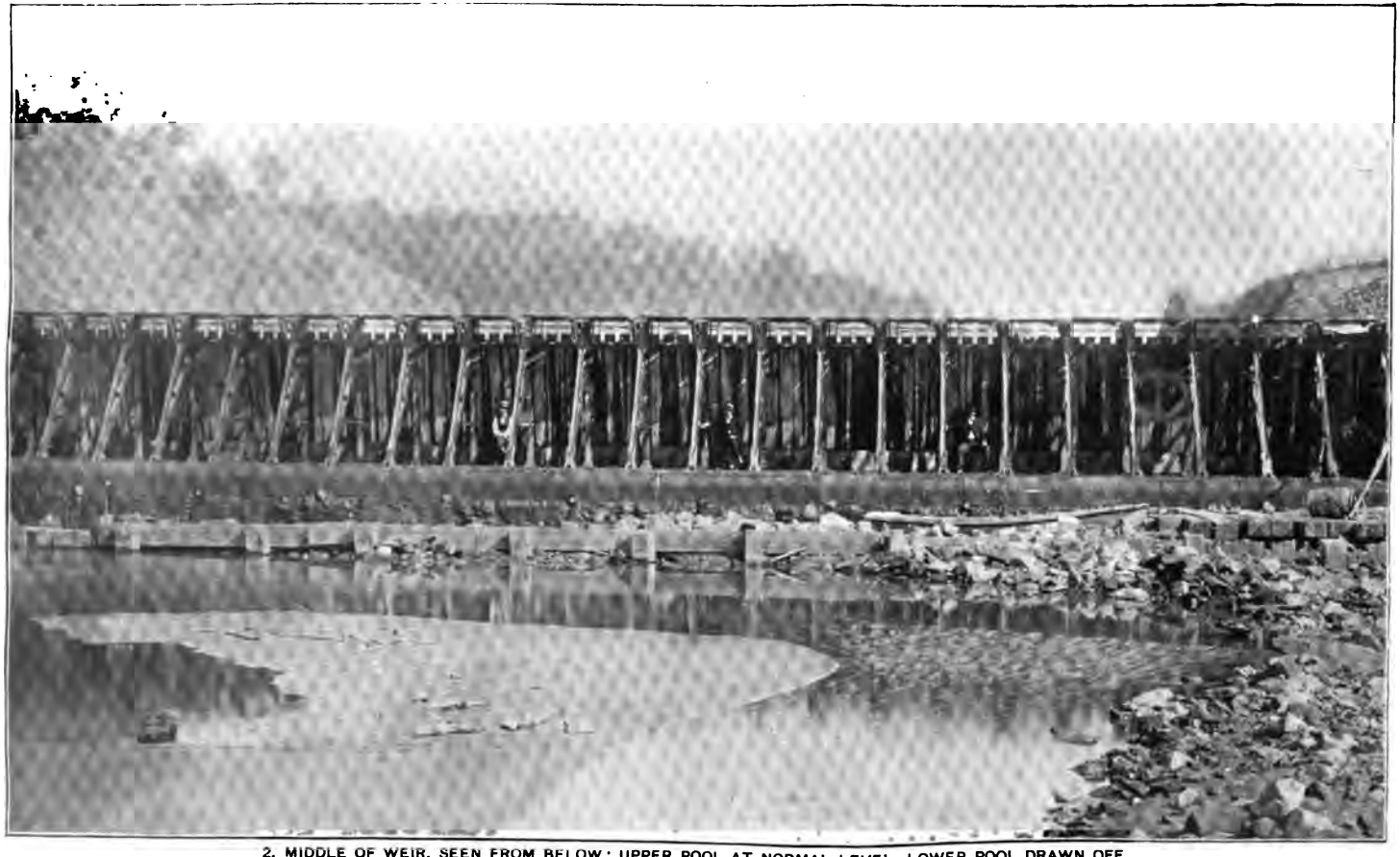

2. MIDDLE OF WEIR, SEEN FROM BELOW; UPPER POOL AT NORMAL LEVEL, LOWER POOL DRAWN OFF.

(Weir 140 feet long, of needles 12 inches wide, 8.25 feet long, 2.5 inches thick at top and 3.5 inches thick at bottom, holding back water, October 22, 1897, to 7 feet height above weir sill, with total leakage of only 1 gallon in 38 seconds, or 0.004 cubic foot per second.)

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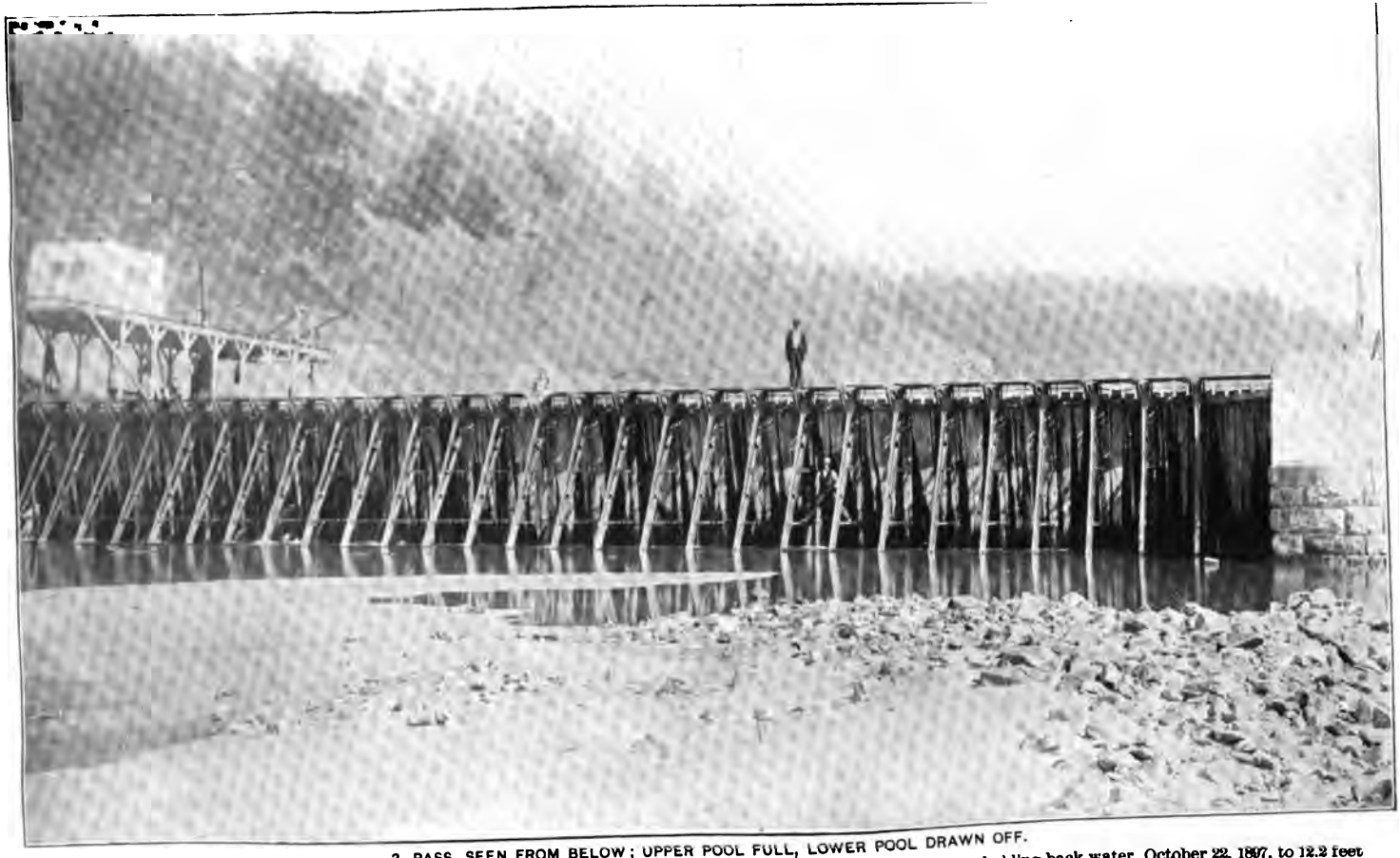

3. PASS, SEEN FROM BELOW; UPPER POOL FULL, LOWER POOL DRAWN OFF.

(Pass 130 feet long, of needles 12 inches wide, 14.25 feet long, 4.5 inches thick at top and 8.5 inches thick at bottom, holding back water, October 22, 1897, to 12.2 feet height above lower pool and 13.2 feet above pass sill, with total leakage of only 5.19 cubic feet per second.)

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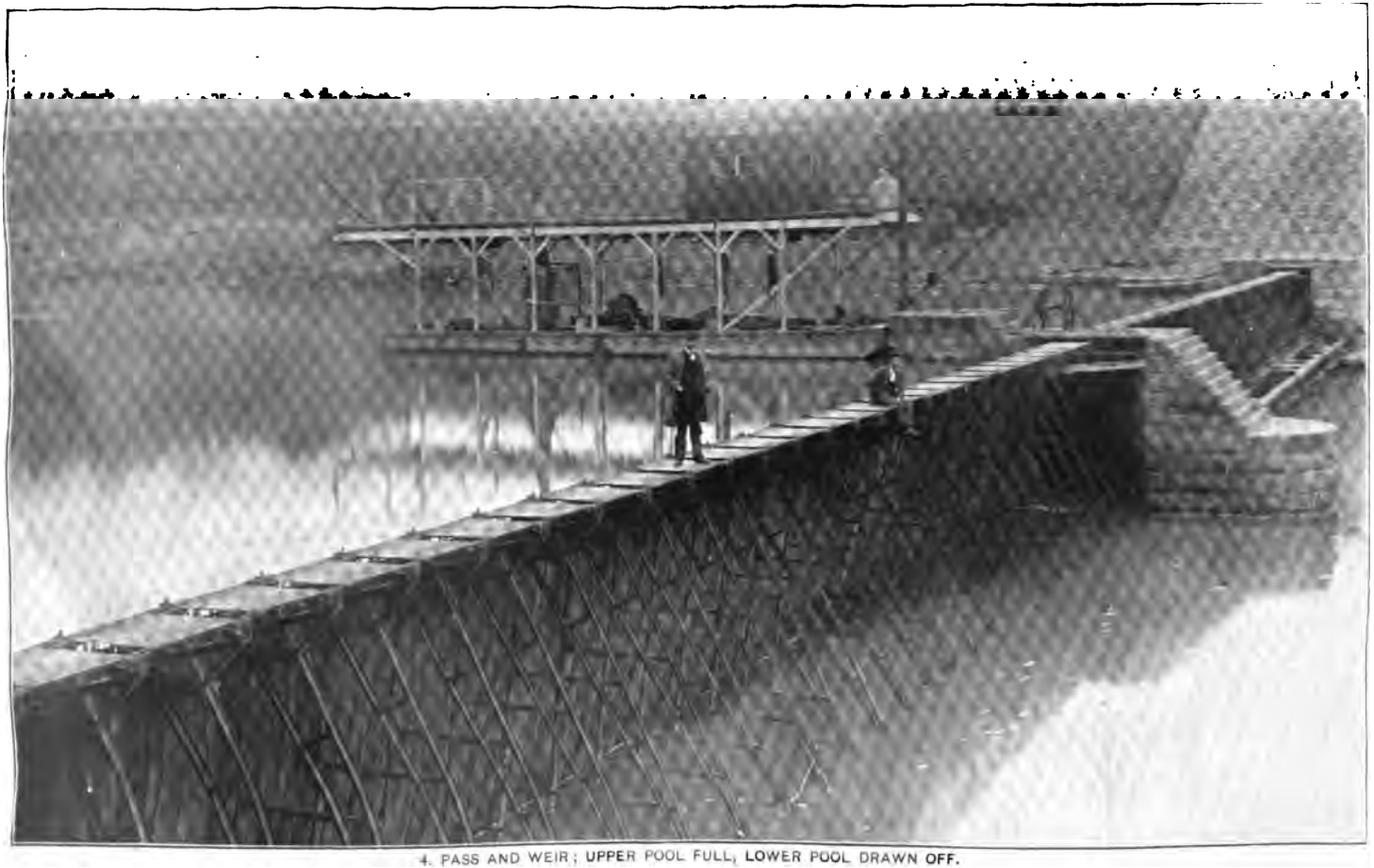

4. PASS AND WEIR; UPPER POOL FULL, LOWER POOL DRAWN OFF.

(Difference of level between pools, 12.2 feet; between upper pool and pass sill, 13.2 feet; between upper pool and weir sill, 7.2 feet. Leakage insignificant.)

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5. LOCK, PASS, AND WEIR; UPPER POOL AT NORMAL LEVEL, LOWER POOL DRAWN OFF.

(Difference of level between pools, 12 feet; between upper pool and pass sill, 13 feet; between upper pool and weir sill, 7 feet. Leakage insignificant.)

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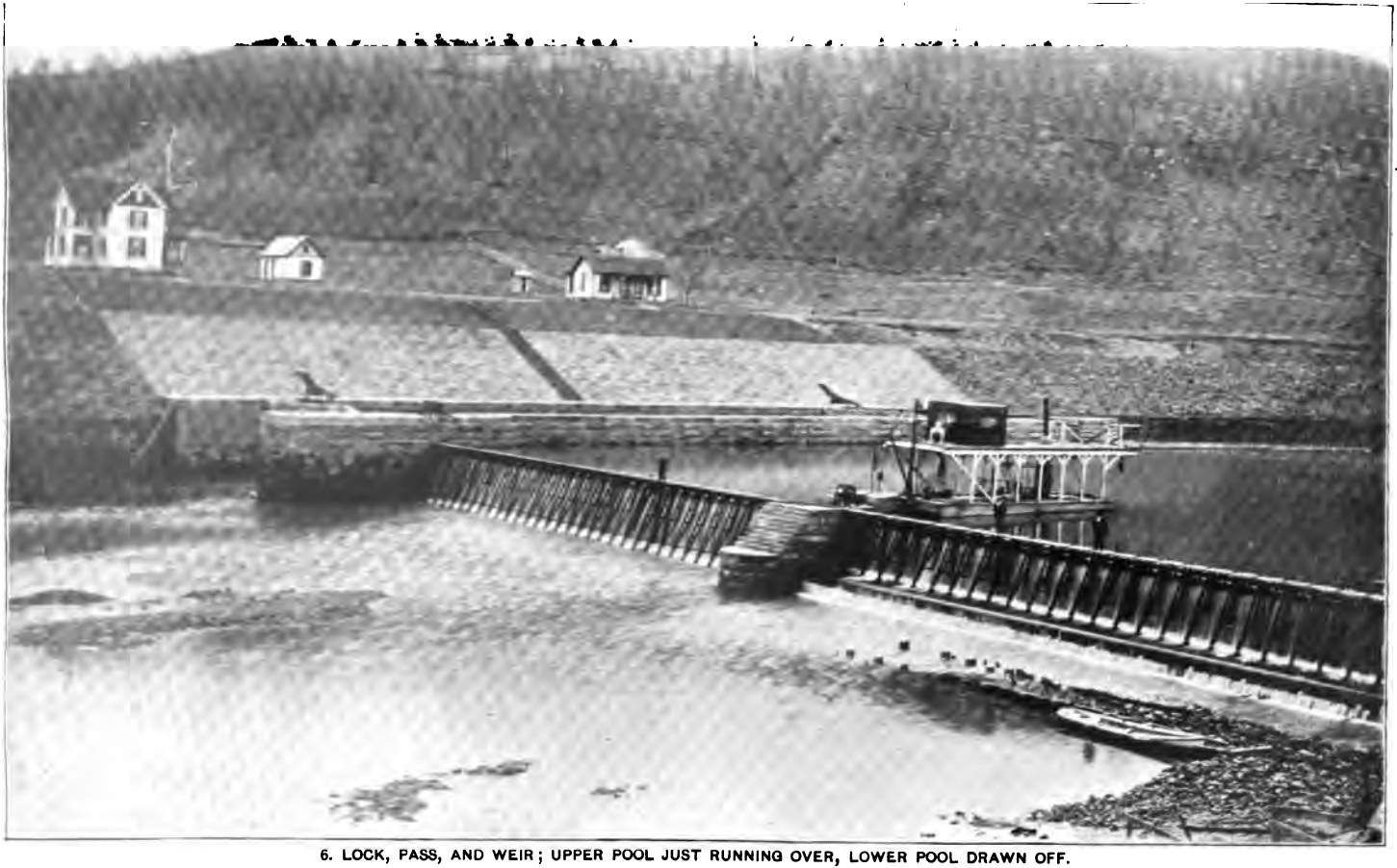

6. LOCK, PASS, AND WEIR; UPPER POOL JUST RUNNING OVER, LOWER POOL DRAWN OFF.
(Difference of level of pools, 12.3 feet; between upper pool pan pass sill, 13.3 feet; between upper pool and weir sill, 7.3 feet.)

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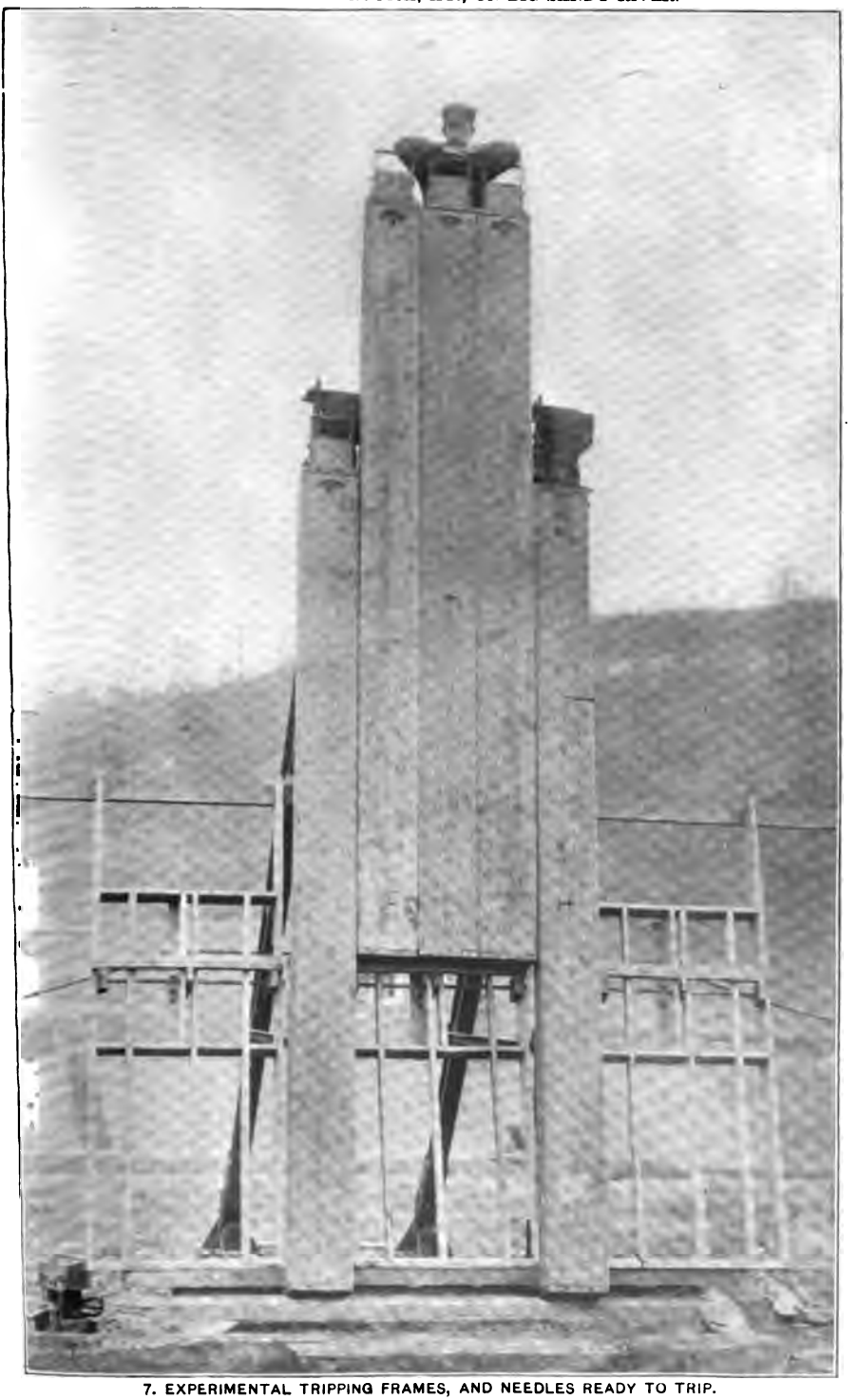
NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.



7. EXPERIMENTAL TRIPPING FRAMES, AND NEEDLES READY TO TRIP.

(These frames, three of which are here shown, are used to support the needles above the water until all needles are in position to trip. Each frame carries a trigger shelf, and all shelves are tripped at once by a single pull on a connecting chain. The outer needles, here shown as resting on the sill and used as guides, may be spaced at such intervals as desired or may be entirely omitted.)

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NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.

8. EXPERIMENTAL TRIPPING FRAMES, AND NEEDLES AFTER TRIPPING

(After the needles are tripped the frames can be removed separately by the assistant standing on the crossbars of the trestle, under shelter of the needles.)

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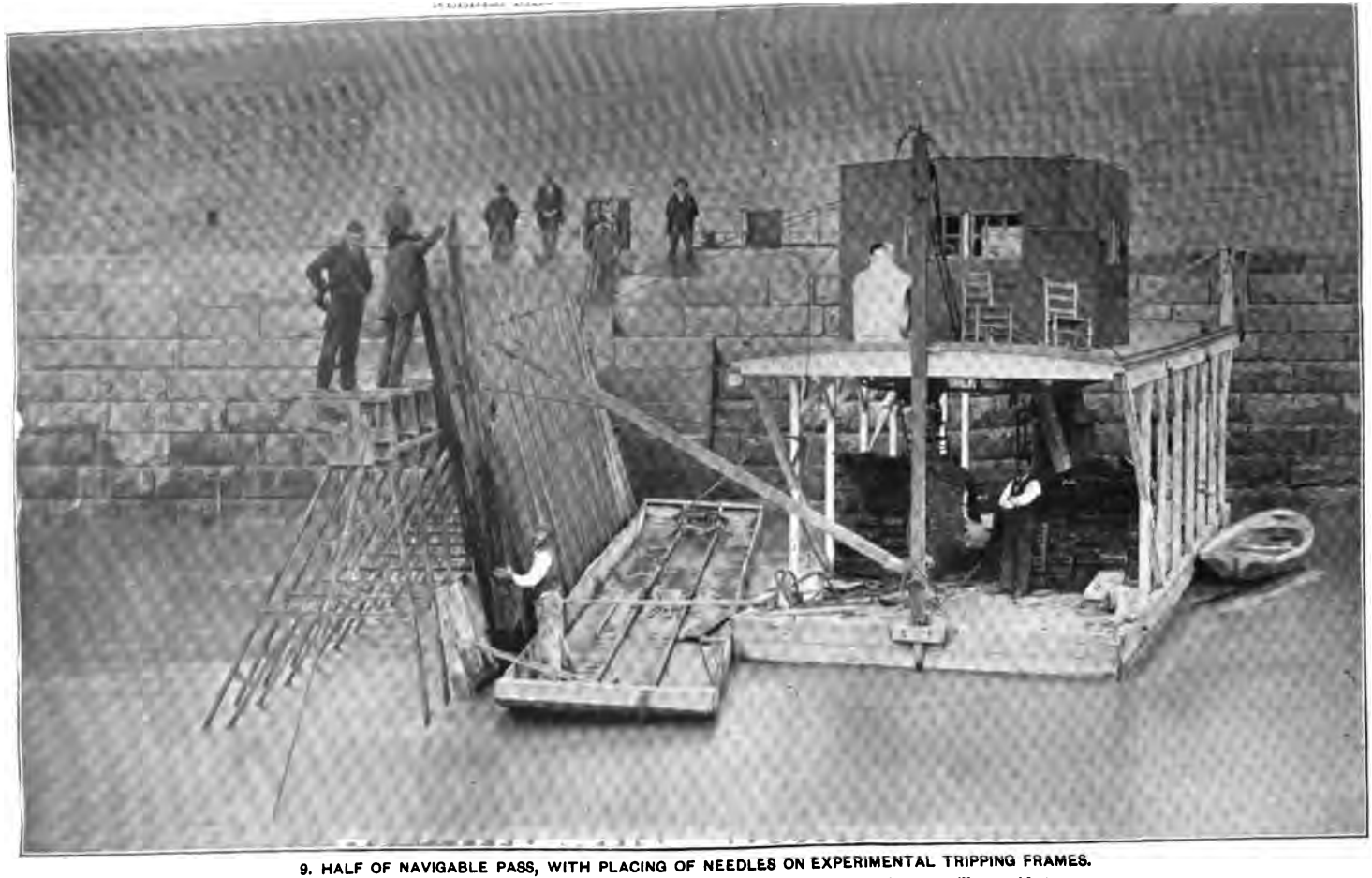

9. HALF OF NAVIGABLE PASS, WITH PLACING OF NEEDLES ON EXPERIMENTAL TRIPPING FRAMES.
(Depth of water, about 3 feet over pass sill; every fourth needle put down to sill as guide.)

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10. HALF OF NAVIGABLE PASS, AFTER NEEDLES HAVE BEEN DROPPED FROM EXPERIMENTAL TRIPPING FRAME.

(Depth of water, about 3 feet over pass sill. One needle is shown as still resting on the frame and a few others as held up a few inches by sand on the pass sill, all others having sunk immediately to proper position.)

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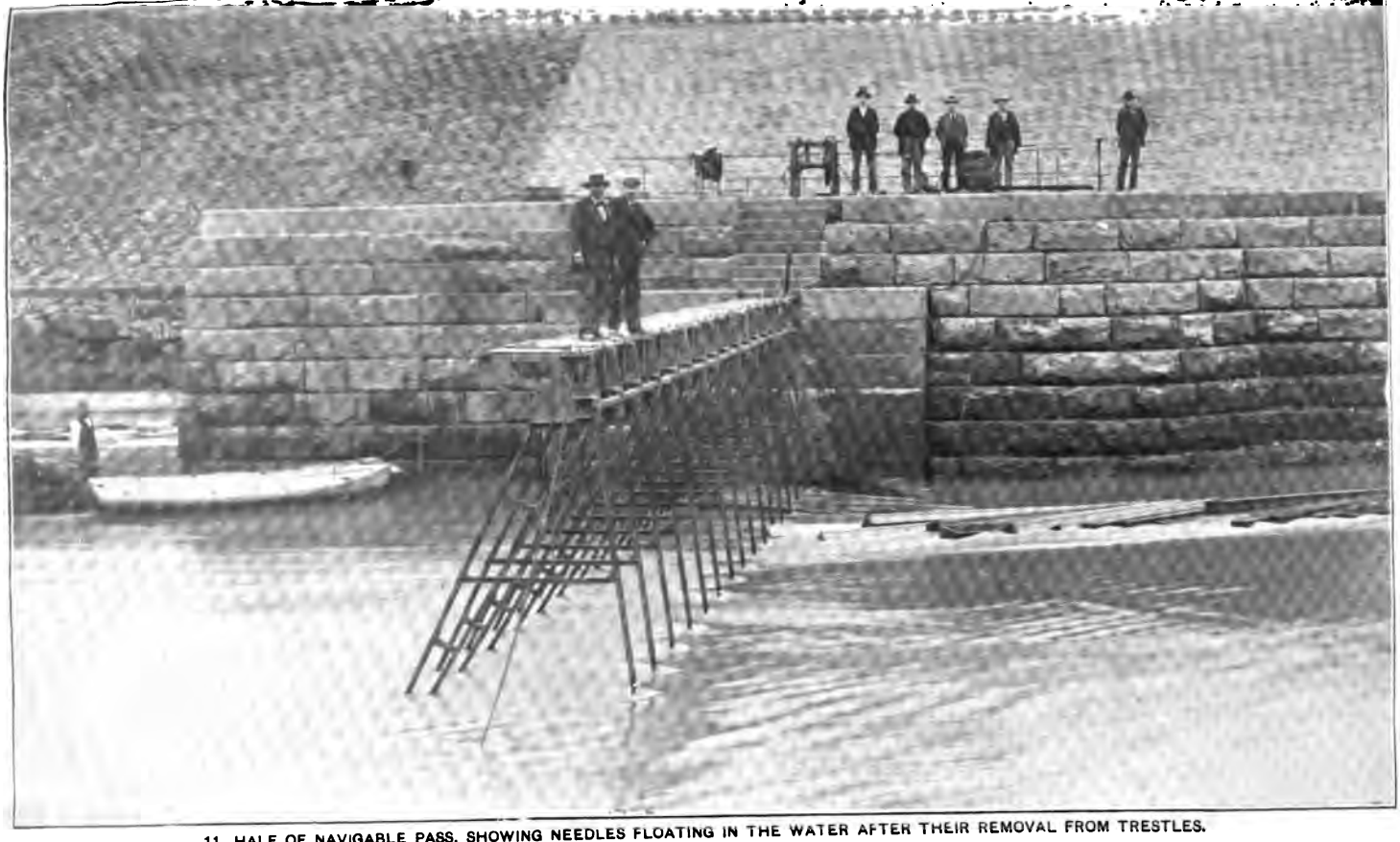
NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.



11. HALF OF NAVIGABLE PASS, SHOWING NEEDLES FLOATING IN THE WATER AFTER THEIR REMOVAL FROM TRESTLES.

(The removal is effected by a single steady but continuous pull of a long chain attached at intervals to all the needles and operated by steam power from a needle boat placed well above the dam. Water about 3 feet deep. In higher water the removal is effected with equal ease and completeness.)

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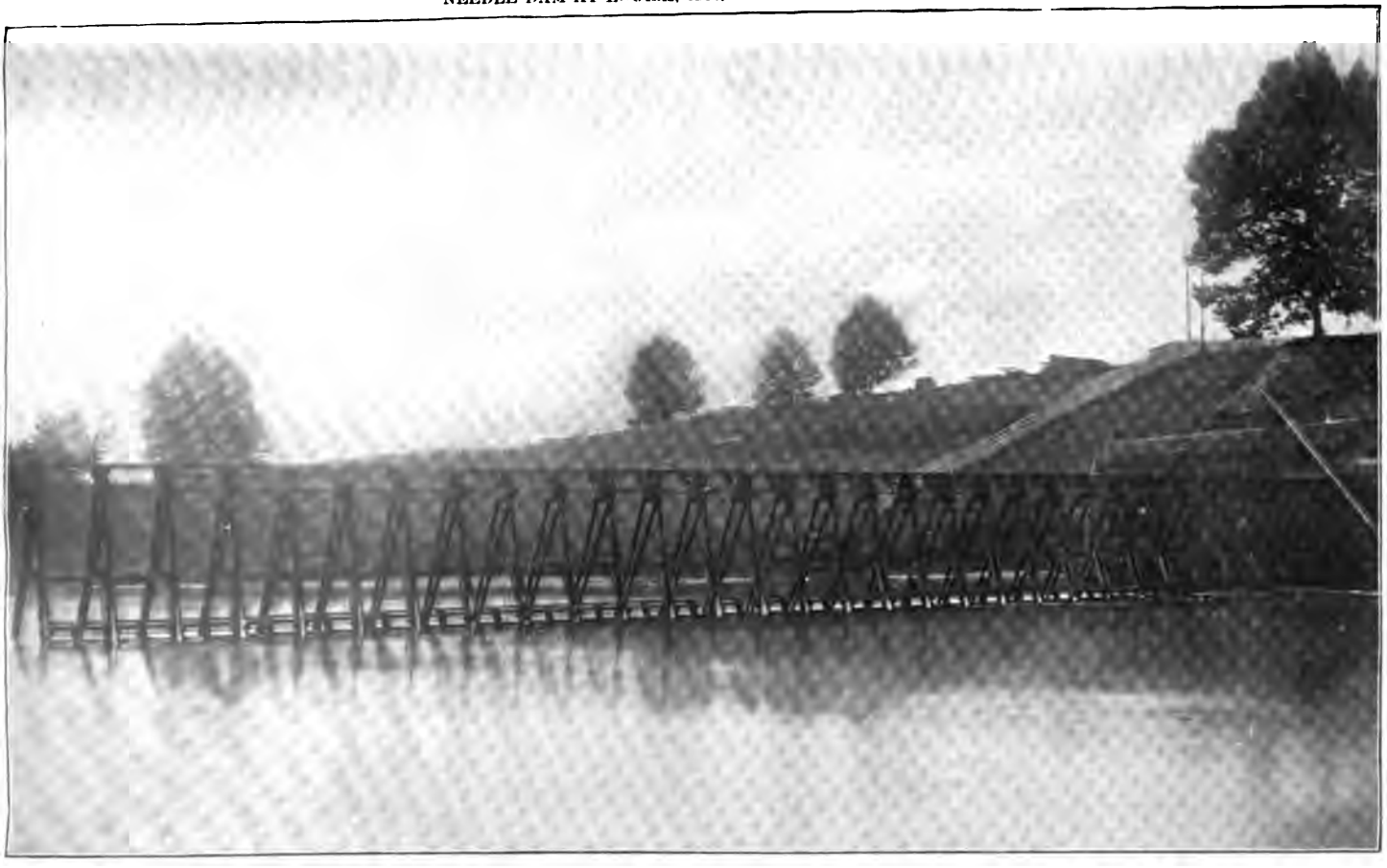

12. ENTIRE NAVIGABLE PASS, WITH TRESTLES AND EXPERIMENTAL TRIPPING FRAMES IN POSITION. WATER ABOUT 3 FEET ON SILL.

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NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.

13. ENTIRE NAVIGABLE PASS, WITH 120 NEEDLES ON EXPERIMENTAL TRIPPING FRAME, ALL READY FOR TRIPPING; AND ONLY 11 NEEDLES, AS END CLOSERS AND GUIDES, RESTING ON SILL.

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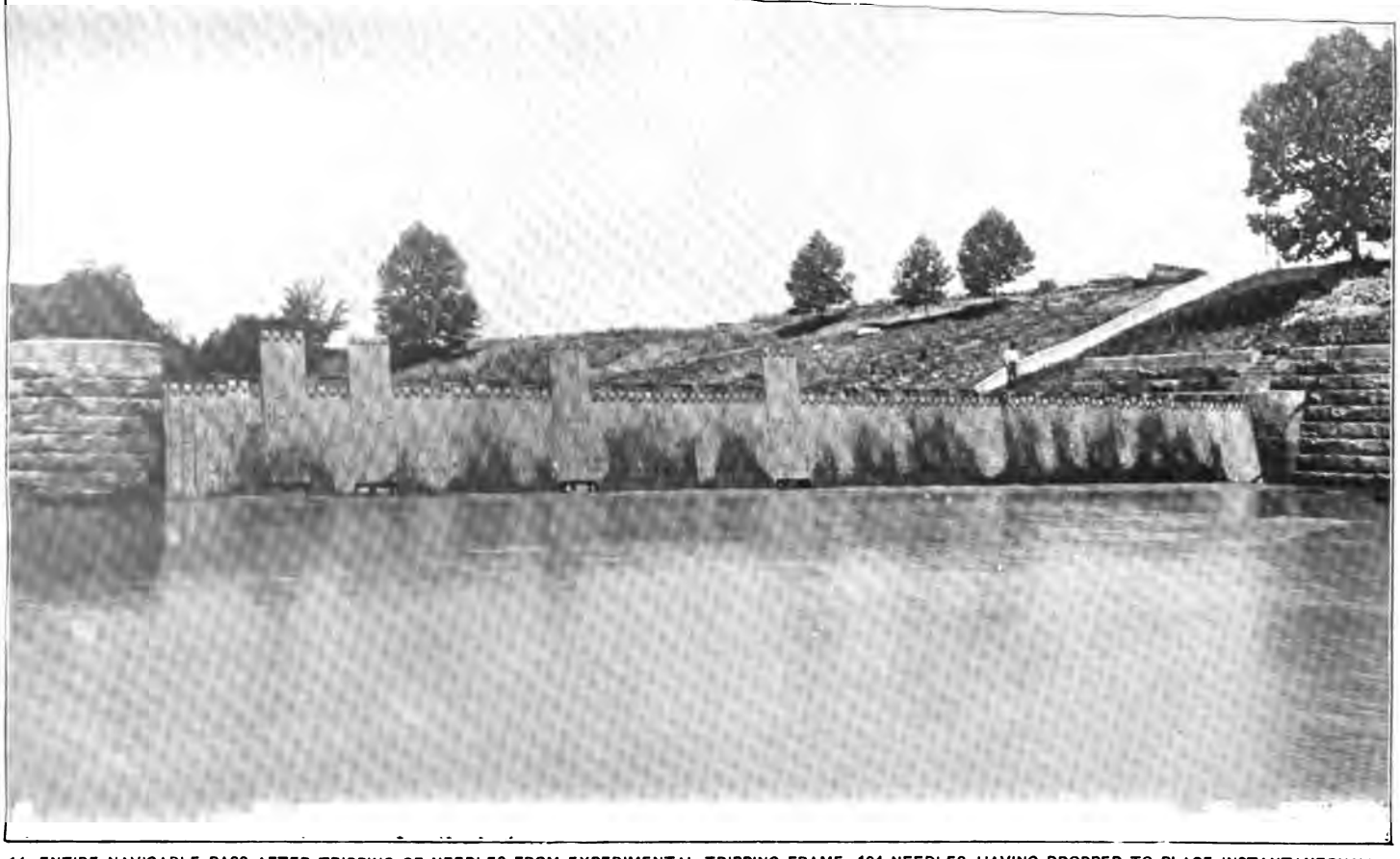
NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.



14. ENTIRE NAVIGABLE PASS AFTER TRIPPING OF NEEDLES FROM EXPERIMENTAL TRIPPING FRAME, 104 NEEDLES HAVING DROPPED TO PLACE INSTANTANEOUSLY, THE OTHER 16 NEEDLES (4 FRAMES) HAVING BEEN HELD BACK BY TIGHT JOINTS UNTIL STRUCK WITH A SLEDGE, WHEN THEY ALSO DROPPED INTO POSITION LIKE THE OTHERS.

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NEEDLE DAM AT LOUISA, KY., ON BIG SANDY RIVER.

15. TOP OF WEIR, SHOWING REPOUSSING (PUSHING BACK) OF NEEDLES.

(Upper pool full, lower pool drawn off; difference of level between upper pool and weir sill, 7 feet. The repoussing bar is a large forked lever. After repoussing, a needle is held back by a short stick placed between the top of the needle and the escape bar of the trestles.)

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List of boats plying Big Sandy River, West Virginia and Kentucky, and Tug and Louisa forks of same.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Beulah Brown	Side-wheel	118	15	2.5	37.41
Sip Bayes	do	110	14	1.8	34.12
Alex Yost	do	120	18.4	.....	56.28
Jennie George	do	93	14	.....	19.05
Fairplay	do	125	19	.....	49
Sandy Valley	do	105	14	2.3	40
Stella (tow)	Stern-wheel	90	16	?	25
Buckeye Boy (tow)	do	137	20	3.5	.....
Gate City (tow)	do	.....	.....	.....	.....
Sea Lion (tow)	do	123	22	3.5	127
J. H. McConnell (tow)	do	120	22	4	137
Lee H. Brooks (tow)	do	.....	.....	.....	.....
Champion (tow)	do	113	21	3.2	60.15
J. C. Hopkins (saw)	Side-wheel	102.5	16.4	2.4	67
B. A. Johnson	do	102.5	16.4	2.4	67
Estelle	do	103	10	2.5	18.35
Ometa	do	45.7	15.5	2.3	3.96
Nancy	Stern-wheel	38	6.5	2.2	.....
Louisa	Side-wheel	.....	.....	.....	.....
Maxie Yost	do	117.6	15.6	.....	47.12
H. G. Stafford	do	.....	.....	.....	.....

List of vessels, rafts, etc., passing lock and dam on Big Sandy River during the fiscal year 1898.

Craft.	Lock.		Pass.		Total.
	Up.	Down.	Up.	Down.	
Steamboats	14	13	226	225	478
Barges and flats	22	27	13	13	75
Log rafts	.....	1	.....	1,142	1,143
Tie rafts	.....	.....	.....	27	27
Miscellaneous	1	1	.....	.....	2
Total	.....	.....	.....	.....	1,725

REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa., June 30, 1898.

MAJOR: I have the honor to submit the following statement of the first year's experience with the needle dam on Big Sandy River, near Louisa, Ky.:

In my last annual report (Chief of Engineers, 1897, pp. 2534–2557) I gave a description, somewhat in detail, of the lock and dam and its appurtenances, the methods adopted in its construction and operation, and a statement of its cost. It is now proposed to briefly mention some of the difficulties encountered, and the means adopted, or suggested for adoption, in order to operate the dam with greater safety and facility.

Drift.—The worst enemy to this type of dam is drift. The early part of the season was one of thunder storms and freshets, and the river was laden with drift much of the time. This drift was a constant menace to the trestles after the needles had been removed and while lowering the trestles. Very small pieces, when caught on a trestle post, were effective in preventing the complete bedding of the trestles, and some delay occurred from this cause. The shear boom was of valuable assistance in preventing all large drift from coming against the dam; but upon removing the needles a stiff current always sets in which draws much small débris under the boom, and not all of this can pass between the trestles into the lower pool. The annoyance from this cause is greater than from any other and can be easily remedied in future construction by increasing the spans of the trestles. As nearly all of this trouble occurs on the weir, it being the part of dam first opened, and as the head here can but little exceed 7 feet, the spacing of the trestles could be readily increased to 20 or even 30 feet without special difficulty, provided the anchorages were properly constructed in the masonry. A special chute for drift should be constructed in future dams on this river.

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Sand.—Some trouble has been caused by the accumulation of sand on the pass trestles when lying down. This sand packs on the trestles at times and renders them difficult to raise. This deposit occurs usually when the backwater from the Ohio is over the trestles at time of a head rise, the sand carried by the rising river above being deposited when it strikes the quiet backwater. Most of the trouble so far from this cause has occurred in the pier recess where the heads of three trestles are bedded. A partial remedy has been found in removing the floor sections from these three trestles before lowering them. The accumulation can be largely cut out in the pass by placing the weir needles some time before the water reaches the weir level and thus increasing the current through the pass. The principal reason the sand is deposited on the trestles is that the sill of the pass was placed considerably below the bed of the river, as it lies above and below the dam, and thus the trestles lie in a trough or depression, which is always trying to fill to the level of the adjacent bars upstream and downstream. This condition was predicted and a remedy suggested in my report of March 20, 1896 (Chief of Engineers Report, 1896, pp. 2312-2313); but it is believed that it will not seriously interfere with the operation of the dam at any time, and that it will not become necessary to raise the sill and trestle recess. Inexpensive artificial means have so far been quite effective in causing sufficient scour to permit all of the trestles, except the three in pier, to be raised. The desired result can be attained by placing a sufficient number of needles next the lock to materially increase the current, or a number of boards may be pushed down along the upstream side of the trestles already raised. One plan often resorted to is to anchor the needle boat immediately over the trestles the night before beginning to raise the dam. This lessens the available waterway and removes the sand effectually. In order to remove the sand from the pier recess, it has been found necessary once or twice to raise all trestles, except the three entering the recess, and then place the needles. This leaves a space of some 14 feet through which the whole river must pass, and it requires but a few minutes for a current to develop which will remove the deposit. It is necessary in such cases to close this space with needles under considerable head, but it has been done without serious difficulty or danger with a head of from 4 to 5 feet. It is a slow process and the needles do not go in close together, necessitating joint covers.

Leakage.—The low-water discharge of the Big Sandy River at one time last summer was less than 50 cubic feet per second. It will be seen that, to maintain a pool under such condition, the waste from all sources must be curtailed to the utmost. It is necessary to place the needles in position with the greatest care as to tightness against the sill at bottom, and then to press them closely against each other with jackscrews so that there may be no space for leakage in the vertical joints. When all has been done that can be in this manner, it is still necessary in extreme low water seasons like the last one, where the dam was in position nearly five months without being opened to pass a rise, to resort to an additional device to hold the pool. This consists of placing sawdust, grass, etc., above the needles, which is drawn by the water into the cracks and joints, the dam becoming practically water-tight. It was impracticable to hold the pool at normal level at all times, and upon drawing it down for some repairs during the dryest part of the season it again filled slowly until running over the crest.

With a head of from 11 feet 8 inches to 12 feet 3 inches the leakage of the entire pass was but 5.19 cubic feet per second, and that of the weir only 1 gallon in thirty-eight seconds.

With proper care in placing the needles this dam will maintain the pool at normal height through the dryest season, and become tighter every day it stands.

Maneuvers.—My annual report (Chief of Engineers, 1897, pp. 2555-2557), described the maneuvers of this dam in detail, and I will only touch here upon some valuable modifications in the methods there exploited. The trestles are raised and the needles are removed practically as there described, but the method of placing the pass needles has undergone a radical change. Instead of placing them one by one in the water, thus confining the waterway and increasing the current at each successive maneuver, and rendering the placing of other needles still more and more difficult, owing largely to the cross current around the wall of needles, they are now placed on shelves attached to frames just above the water level, and, when all have been so placed, the shelves are dropped simultaneously by a simple mechanism; the needles all strike the water almost vertically at the same instant, and go against the sill with only the natural current of the river slightly augmented by the raising of the trestles and frames, and the placing of a few guide needles here and there.

At the close of Part V of the description of Louisa dam, published in the Annual Report for 1897, it was stated that experiments looking to the improvement of the method of placing the needles were being made and would be described in a subsequent report. In the same paragraph mention is made of the employment of steam on the needle boat for maneuvering the trestles. This has not yet been adopted, as we have but a single-cylinder engine, which is not suitable for a steady movement. It is proposed to replace this with a hoisting engine with a double cylinder as soon as practicable, when, it is believed, the plan can be advantageously carried out.

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I will now briefly describe the method of placing needles as finally adopted and successfully instituted on January 12 last.

Placing the needles.—The needles in the pass of the Louisa dam weigh about 275 pounds each and are 12 inches in width. They are placed by three men with the greatest ease and dispatch, and it is possible to close passes of any width without increasing the head beyond a few inches while so doing. During the coming season it is proposed, for experimental purposes, to use a dozen needles 3 feet or 4 feet wide each; that is, as wide as a Chanoine wicket. The method is as follows:

A series of light frames having upright slats or rods resting on the sill at bottom and against the trestles at top are placed across the entire pass. Just above the water level, at the stage at which it is proposed to place the needles, each frame carries a little shelf fastened in middle on a trigger, the downstream end of which is held in place by an upright lever. The two ends of shelf are supported on hinges connected with the frame. The simultaneous throwing of these levers, when the needles are standing on the shelves, will release the triggers and permit the shelves to revolve and drop the needles into the water, when the slats, or rods, of the frame will prevent their being carried over the sill and guide them into place. For the purpose of simultaneously releasing the triggers all the levers are connected with a light chain stretched across the pass and resting in claws in the tops of the levers. One end of the chain is made fast until all is ready, when it is released, which operation permits all the levers to fall, thereby releasing the triggers and causing the needles to drop into position instantly. This invention has proved wholly satisfactory, and permits the dam to be erected with the regular force of three men using the steam derrick on the needle boat for placing the needles on the shelves. A number of the needles may be placed above the frames directly against the sill, and thus act as guides to the others if desired. This method will readily admit of the use of needles 4 feet wide, weighing over 1,000 pounds, and of placing them on the shelves ready to drop at the rate of one needle per minute. In a new dam there is no doubt but that the trestles can be so designed that the needles can be placed simultaneously without the use of frames.

Regulating the pool.—When the pool has once filled, it is necessary to provide for the escape of the surplus water. Authorities on movable dams have pointed out the dangers liable to arise from permitting the needles to overflow, but with due regard to these authorities the writer can say that there is no danger whatever in allowing an overflow of a few inches depth. In fact, were the needles to be replaced, he would certainly recommend a design which would permit almost an unbroken spillway along the crest.

The construction of the needles for this dam is such that only about one-third the width of each needle can be submerged without raising the pool several inches above its normal height, and it was necessary to adopt some other means of wasting the surplus water, particularly on a rising river. This method consists in pushing back the head, repoussing, alternate needles. As there is a pressure of some 550 pounds on the head of each weir needle, it was necessary to devise means of pushing them upstream. A homemade ratchet jack was used for some time with success, but as it was rather slow for a rising river it was decided to devise something which would do the work rapidly. While engaged in the study of this, the writer was surprised to find in De Lagrene's "Cours" not only a suggestion that needles might be repoussed (although it had not been done) and held back by sticks placed across them and onto the adjacent needles, but also that he described a jack which he thought might be used for the purpose. The needles here were not of a design suitable for being moved with such a device (the lever being inserted behind the needle), but another was soon designed, after a practical test of a model or two, which has up to this writing given good satisfaction. It is little more than a forked wooden lever, the two legs resting on the upstream faces of the adjoining needles, while a catch drops over the head of the needle to be pushed back. By pushing the lever upstream the head of the needle follows, the legs passing each side and sliding slightly on the other needles in turning. By describing an angle of 90 degrees with the lever, the head of the needle is carried 12 to 15 inches upstream and the pin for holding it is introduced with a pair of tongs. A light floating platform is used in order better to describe the angle with the lever, but the device can be so made, by bending the handle down to the footbridge, that the whole operation can be performed without the float. To replace the needles the operating of the lever may be reversed, or they may be checked down with a line passing around a snubbing post on the float. It is probable that the lever will soon be improved by placing rollers at the ends of the legs and by arranging it so that the entire work may be done from the footbridge without the use of a float.

Removing the needles.—This operation was described in my last report, a part of which is quoted here:

"Near the top of each needle is a countersunk handle for use only in removing the needle; a chain much longer than the length of dam is passed along the upstream side of the needle and connected by hooks with these handles; there is considerable length of slack chain between each pair of handles; the end of the chain is fastened to a long line leading to the engine of the needle boat, which is anchored well

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upstream. By starting the engine the first needle is pulled away from its support at top, and when it has traveled the length of slack chain leading to the next the second is started, and so on until all are removed and are afloat. This maneuver is very rapid, the time required being simply that which is necessary to wind the rope on the drum of the engine. The boat is anchored in such direction that the needles float into the quiet water above the unremoved portion of the dam."

At the time the above was written it was the custom to unhook the needles from the chain and pile them on the boat, so as to be ready when they were to be replaced in the dam. The present method of placing the needles obviates the necessity for loading them on the boat, so they are left in the water and are not unhooked from the chain until the time has come to place them in the dam. This saves considerable time and much labor, prevents wear and injury to the needles and boat, and allows them to remain wet all the time. While this method of removing needles is one which can be applied with great speed (the whole weir, 140 feet, can be removed in a minute), yet it is somewhat injurious to the needles first removed, and the trestles, as the bottoms of the needles strike the trestles with great force, sometimes just as they leave the sill. The principle of opening against the current is wrong, as the great head of water behind the needles should be utilized in lowering them. This is the case where escapement is practiced, but this has been found inconvenient and exceedingly injurious to the needles because of their width.

In future dams a simple remedy can be applied by means of which needles may be escaped downstream without injury. This consists in placing the needles below (or downstream of) the trestles and holding their heads by suitable attachments to bars connecting the trestles. The releasing of the attachments or hooks will allow the needles to fall.

Results.—To those who have read the description of this dam in the last Annual Report, the results of its operation so far will be of interest. They may be considered from the engineer's standpoint solely, as the advantages to navigation from a single dam, isolated from continuously navigable water, are, of necessity, not numerous or valuable.

The dam at Louisa is a pioneer. It is the first needle dam built in the United States and believed to sustain the greatest head of any of its class in the world. Many of its features are entirely novel and have nowhere else been applied. The needles are much heavier, the trestles much lighter and of novel design, the methods of maneuvering both needles and trestles are radical departures from past custom, and the dam is practically water-tight.

The experience so far had with this dam has demonstrated the following:

(1) Needle dams may be operated successfully on torrential, silt-producing, drift-bearing streams.

(2) Pools can be maintained with this class of dam at times of minimum discharge.

(3) Dams of this type may be used for extraordinary lifts.

(4) The use of wide needles (up to 4 feet or more) is wholly possible and even advisable under some circumstances.

(5) The placing of all needles simultaneously without increasing the head of water is possible for any ordinary width of waterway.

(6) The maneuvers of the trestles may be performed by a stationary crab on shore with great speed and ease.

(7) The removal of the needles can always be as speedy as required.

Administration.—In my last year's description of the dam I neglected to complete its history in the matter of mentioning those connected with the work in an administrative and engineering capacity. Officers in charge at various times to the present, given in the order of their succession, were: Lieut. Col. Wm. E. Merrill, Maj. James W. Cuyler, Maj. Jas. C. Post, Maj. D. W. Lockwood, Maj. James F. Gregory, Maj. W. H. Heuer, Lieut. Wm. W. Harts, and Maj. W. H. Bixby.

There have been two Boards of Officers, as follows:

Col. Wm. P. Craighill, Maj. D. W. Lockwood, and Capt. Thomas Turtle.

Col. Amos Stickney, Maj. James F. Gregory, Maj. D. W. Lockwood, Capt. H. M. Chittenden, Lieut. W. E. Craighill, and Lieut. Wm. W. Harts.

I have had as assistants in various engineering, designing, and superintending capacities Messrs. R. H. Gamble, George Strachan, John Faris, Harry Hedge, J. C. Thomas, D. A. Watt, John M. G. Watt, J. D. Flenniken, P. M. Bess, E. W. Foreman, W. V. H. Rose, and L. S. Johnson, and I take pleasure in testifying to their efficiency.

The works are now in charge of T. J. Snyder, lock master, with Will G. Rathbone and James Pigg as lock tenders. These men have been zealous in their endeavors to make the dam a success, and have shown much more than ordinary intelligence and care in its operation and preservation. The result of this is that there is no injury to the dam itself, no hindrance to navigation, and no casualties of any kind to report in connection with its operation and maintenance, as there were none in connection with the construction.

Respectfully submitted.

B. F. THOMAS, *Resident Engineer.*

Maj. W. H. BIXBY, *Corps of Engineers, U. S. A.*

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REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa, June 30, 1898.

MAJOR: I have the honor to submit the following report on improving Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1898:

Grounds.—The grounds on Kentucky side of river, at Louisa, were thoroughly cleaned and graded and sown in grass seed. Rejected timber, belonging to Marting, Mittendorf & Duis, which had long been in the way, was removed to a point below high-water mark. The old temporary cement shed was torn down and rebuilt on a less-used portion of the land for tool shed. The banks were sodded at points where liable to wash.

The grading of the main grounds on the West Virginia or lock side of river, which was begun last year, was completed; the banks were sodded above the line of riprap and the newly graded portions sown in grass seed. Ditches and culverts, for preventing the water from injuring the grounds, were made at suitable points.

A new fence of undressed poplar and locust posts was placed about the main grounds on each side of river, and the fence, tool shed, and office building were whitewashed.

Protection works.—Some trouble from erosion below the abutment, caused by lowering the dam before the water had risen enough below, has been encountered, and it has been necessary to gradually protect the threatened places.

For this purpose 445 cubic yards of broken stone has been used, and it is probable that more will be required from time to time. By this means the paving has been held in place without serious derangement.

A leak, believed to have been caused by muskrats following the old cofferdam timbers, was developed around the abutment, and it has been necessary to add to its protection. This was done by driving and placing sheet piles behind abutment, building a crib immediately above it, and filling same with rammed clay, and filling in behind with small-sized broken stone. To do this it was necessary to remove 300 cubic yards material from behind abutment, take up 280 square yards paving, and replace the same later on. Three hundred and seventy-five cubic yards of stone and 280 cubic yards of clay were placed behind and above the abutment, and 3,500 feet B. M. of oak lumber used. The leak was lessened, but not stopped, and much of the clay gradually washed out, which was replaced with fine broken stone. While it may not finally stop the leak, it will prevent washing and dangerous encroachment on the bank below abutment. Two hundred and twenty-five cubic yards of this stone has been prepared and placed at the abutment to be used as required during the present season.

Miscellaneous work.—Very little miscellaneous work, outside of that chargeable to operating and care, has been done. The most important is probably the painting of the trestles, which were badly rusted, not having been heretofore painted, except the coat given them in the shop. The sand in the river cuts the paint away rapidly, and it is probable that constant care in this regard will be necessary to prevent the attacks of rust.

The riprap at upper end of property, where the bank is quite steep, slipped down and had to be replaced.

A small cabin was added to needle boat for use of the men on watch at night, and a light derrick was placed on the boat to be used in connection with the engine used for lifting the needles from the river and placing them on the shelves ready for dropping. This obviates the necessity of piling the needles on the boat, and saves much time and labor.

The lower approaches to lock and pass were thoroughly cleaned of all bowlders, gravel, etc., during the extraordinarily low water of last summer, it not having been possible to properly do so previously on account of water.

Frames, for placing needles simultaneously, were made and floor chains placed on the trestles for further safety in lowering.

New maneuvering chains have been added to those already on the trestles in order to enable us to lower the trestles separately when desirable. Chains and hooks for removing the needles have also been put on.

Work remaining to be done.—The unfinished work consists in placing water gauges on the lock walls, smoothing up the ledge and building a wall thereon below lock to replace the old crib, building walks, making some needed modifications in the trestles, etc., building a push boat for general use about the dam, and other work of small amount. This work would have been completed but for the fact that it was feared the available funds might be required for further protection at abutment. As soon as it is determined that the abutment is safe the work will be completed. Should sufficient funds remain an additional lock house should be built, to make one for each lock tender.

River below Louisa.—I call attention to the remarks in my last annual report as to the condition of the channel below Louisa, and the recommendation for doing some-

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thing there is renewed. This is a very important stretch of the river and is almost unnavigable at a mean low-water stage because of the snags in the channel.

Respectfully submitted.

B. F. THOMAS, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 16.

OPERATING AND CARE OF LOCK AND DAM IN BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. Wmilliam W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The lock and dam near Louisa, Ky., was finished under the appropriation for improving Big Sandy River, West Virginia and Kentucky, during the last fiscal year, and was placed under the indefinite appropriation on July 1, 1897.

There was no interruption to navigation, the dam sustaining a pool level during the entire dry season—one hundred and forty-two days—of last summer and fall. In addition to operating and care, some minor repairs and improvements were made to the lock and dam.

The maneuvers of the needle dam were most satisfactory, but some improvements to further facilitate operation suggested themselves, which will be made.

The commercial statistics of this stream are included in the report for improving Big Sandy River.

This work has been carried on most efficiently under the local supervision of Mr. B. F. Thomas, resident engineer, whose report in detail, giving the maneuvers of the dam, is herewith appended.

Allotment.

July 23, 1897 ..... $2,840

Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Big Sandy River, West Virginia and Kentucky, during the fiscal year ending June 30, 1898.

No. of voucher.	To whom paid.	For what paid.	Amount.
	August, 1897.		
23	Sundry persons	Service	$150.00
24	J. C. Bowles	do	2.50
25	William O'Brien	do	2.50
26	John Ward	do	2.50
79	Sundry persons	do	100.00
	Total		257.50
	September, 1897.		
106	Pay roll	Service	.75
107	do	do	156.45
178	John Ward	Services	2.50
179	J. C. Bowles	do	2.50
216	William O'Brien	do	2.50
280	Western Union Telegraph Co	Toll on telegram	.20
306	Pay roll	Service	150.00
	Total		314.90

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Detailed statement of expenditures for operating and care of canals and other works of navigation, applied to Big Sandy River, etc.—Continued.

No. of voucher.	To whom paid.	For what paid.	Amount.
	October, 1897.		
31	William O'Brien	Services	$2.50
32	John Ward	do	2.50
33	J. C. Bowles	do	2.50
101	C. Whithorn	Rubber stamps	.60
182	Adams Express Co	Freight	.50
	Total		8.60
	November, 1897.		
84	Pay roll	Service	152.70
46	Tettenborn & Co	Oil heater and wicks	7.15
47	The Robert Clarke Co	Job printing	16.00
99	The C. F. Bradley Co	Record books	9.00
126	J. C. Bowles	Service	2.50
127	John Ward	do	2.50
128	William O'Brien	do	2.50
	Total		192.35
	December, 1897.		
19	Pay roll	Service	150.00
34	William O'Brien	do	2.50
35	J. C. Bowles	do	2.50
36	John Ward	do	2.50
	Total		157.50
	January, 1898.		
3	Pay roll	Service	150.00
28	William O'Brien	do	2.50
29	J. C. Bowles	do	2.50
30	John Ward	do	2.50
189	Pay roll	do	152.70
	Total		310.20
	February, 1898.		
20	James Simpson	Service of teamster with team	1.96
75	J. C. Bowles	Service	2.50
76	William O'Brien	do	2.50
77	John Ward	do	2.50
P 81	C. Whithorn	Rubber stamps, etc	1.00
84	Augustus Snyder	Oil, etc	15.55
88	James Simpson	Hire of teamster with team	1.96
122	Pay roll	Service	150.00
	Total		177.97
	March, 1898.		
36	J. C. Bowles	Service	2.50
37	John Ward	do	2.50
38	William O'Brien	do	2.50
84	The Chesapeake and Ohio Rwy. Co	Transportation	8.10
	Total		15.60
	April, 1898.		
3	Pay roll	Service	150.00
92	do	do	3.50
96	do	do	2.50
	Total		156.00
	May, 1898.		
44	Pay roll	Service	150.00
64	do	do	3.50
65	do	do	2.50
95	do	do	2.50
	Total		158.50
	June, 1898.		
26	Pay roll	Service	150.00
27	do	do	2.50
43	do	do	3.50
44	do	do	2.50
P 151	Augustus Snyder	Material	26.70
161	Western Union Telegraph Co	Telegram	.22
169	J. D. Barret	Delivering telegrams	2.00
	Total		187.42

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Summary of expenditures for operating and care of lock and dam on Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1898.

Office expenses, superintendence, and contingencies	$109.20
Labor	1,745.60
Expenses	81.74
Total	1,936.54

REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa., June 30, 1898.

MAJOR: I have the honor to submit the following report on operating and care of lock and dam in Big Sandy River, near Louisa, Ky., for the fiscal year ending June 30, 1898:

Operating dam.—The dam was raised on June 30, 1897, and was up at the time of my last annual report. It was lowered on July 2, was raised again on July 10, and lowered on the 24th. It was raised August 1, and remained up till December 20; it then remained down till June 11. With the exception of a small leak around the abutment, caused by muskrats working along the old cofferdam timber, the dam has been in excellent condition throughout the year. Its ability to hold the water to pool level during an exceptionally dry season lasting nearly five months was fully proven. The dam was raised three times and lowered four times, and was up 168 days during the year, 142 consecutively.

It has been found necessary to employ but little extra labor in the maneuvers, and such work will be still further reduced by improvements in the methods employed for placing the needles.

Lock.—The shoe of the shaft of one of the discharging valves was broken in some unknown manner, and it was necessary to coffer the opening to replace it.

Small portable capstans were made in the shop and placed on the walls for assisting in opening the gates.

Maneuvers of dam.

Maneuver.	Date.	Time required.	Remarks.
		Hours.	
Lowered	July 2	4	No difficulty.
Raised	July 10	10	Raised slowly on purpose; no difficulty.
Lowered	July 24	4	No trouble.
Raised	Aug. 1	8	Needles placed from swinging shelves with fair success.
Lowered	Dec. 23	1½	No difficulty; escape bars rusty and hard to turn. Weir lowered on the 20th.
Raised	June 11	4	No trouble.
Lowered	June 18	5	Broke needle chains.

Respectfully submitted.

B. F. THOMAS,
Resident Engineer.

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 17.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

Work of improvement, under the project adopted in 1880, was resumed in August. The following obstructions were removed: Seventy snags, 19 trees, and 45 stumps. One tree was topped, and 1,495 cubic yards of

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rock excavated. The walls at Yoces Sluice, which had been torn down, were repaired and rebuilt.

The original project for improvement has been practically completed, but its maintenance will require attention each season to keep the channel unobstructed. An estimate of cost and full report on the further improvement of this stream by locks and dams was submitted by me under date of April 27, 1898, printed as H. Doc. No. 456, Fifty-fifth Congress, second session.

For details of the work done during the past fiscal year attention is invited to the report of Mr. B. F. Thomas, resident engineer, herewith.

Money statement.

July 1, 1897, balance unexpended	$738.75
June 30, 1898, amount expended during fiscal year	722.64
July 1, 1898, balance unexpended	16.11
Amount that can be profitably expended in fiscal year ending June 30, 1900 (all of which is for maintenance)	1,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

June 14, 1880	$2,500	July 13, 1892	$2,500
March 3, 1881	2,000	August 18, 1894	2,500
August 2, 1882	5,000	June 3, 1896	2,000
July 5, 1884	5,000		
August 5, 1886	3,750	Total	27,750
September 19, 1890	2,500		

Commercial statistics for calendar year ending December 31, 1897.

Timber	tons	85,000
Ties	do	20,000
Staves	do	200
Tan bark	do	200
Miscellaneous	do	30,000
Total	do	135,400
Passengers	number	2,000

The tonnage is decreasing slightly owing to new railroad facilities.

REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa., June 30, 1898.

MAJOR: I have the honor to forward herewith my report upon the improvement of the Tug Fork of Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1898.

Characteristics.—The Tug Fork is the second tributary in size of the Big Sandy River. It flows in a northwesterly direction from the Flat Top Mountain range and is navigable for steamboats about 60 miles for an average of four months a year. Push boats navigate it for 100 miles the greater part of the year. Since the construction of the Norfolk and Western Railway along that portion lying 40 miles above its mouth, the Tug Fork commerce has decreased perceptibly and the necessity for maintaining the upper portion is less imperative. The lower portion, between the mouth of Pigeon Creek and Louisa, 40 miles, has no other mode of transportation.

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Original condition.—Previous to the commencement of improvements on this river the channel was badly obstructed by snags, trees, rocks, etc., and the shoals were irregular and difficult of ascent or descent owing to the crookedness of the chutes, or even the absence of chutes; the bends were rendered unsafe at certain stages because of projecting rocks of immense size off of which it was often impossible to keep timber rafts; overhanging trees added to the danger of steamboat navigation, and, taken altogether, it was always at some considerable risk that navigation was carried on, particularly after nightfall. Even at a good stage of water navigation was unsafe on account of the liability to run onto hidden obstructions. The maximum width of the channel did not exceed 30 feet with a mean low-water depth of 1 foot. While the river in that condition was not even a fairly good waterway, yet it was utilized as the best means available, there being no railroads in that section at that time.

Plan of improvement.—The project for the improvement of this stream, adopted in 1880, provides for removing snags, rocks, overhanging trees, and forming low wing dams of loose stones at shoal places, to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push boat, and raft navigation. The general plan of carrying on the work adopted has been to send out, during the low-water season, small, light-draft push boats, with limited accommodations for a crew of from 12 to 25 men and for storing sufficient explosives, tools, etc. A simple hand crab is provided for use in pulling the boats over shoal places, and occasionally for removing a snag or tree.

The removal of snags, trees, stumps, etc., is generally accomplished with dynamite, but as the water is usually at its lowest this can frequently be done with axes. All bowlders and loose stones are removed from the chutes in the shoals and piled up alongside in ridges called walls, the purpose of which being to confine the water. These walls have connection with the bank, and at a steamboat stage are generally submerged to such an extent as not to be in the way. Formerly wing dams were built of timber and stone at many of the worst places, and, while most of these have decayed and gone to pieces, the more important ones have been repaired at intervals and are still of service to navigation. While none of the regulating improvements may be called permanent in character, yet they have been and are still of incalculable benefit to the river interests, and will, if maintained, answer the purposes of navigation until a better system (canalization) can supply the deficiency. Even then their usefulness will not cease, as they will guide and control the channels at such times as dams can not be kept up.

Results and advantages.—Work under the project has been continued from time to time with small appropriations, and the river has been brought to almost as good a navigable condition as is possible without slack-water improvement. The steamboat channel has been kept clear of obstructions, and the walls of the push-boat chutes have been kept in repair. The shoals have been cleaned, chutes straightened, and the water confined to the channel. At mean low water, boats drawing 20 inches have found no difficulty in making their trips. In extreme low water only push boats, having a draft of less than 1 foot, have been successful.

Operations.—A crew of 14 men was sent out late in August, 1897, under the immediate charge of Mr. Fred McHenry. They were provided with dynamite and tools, and lived on a quarter boat drawing about 4 inches. The quarter boat and tool boat were pushed to Pigeon Creek, where work was commenced downstream toward Louisa, obstructions of various kinds being removed at Pigeon Shoal, Carter Shoal, Long Branch Shoal, John Pasley Shoal, Yoces Sluice, Star Ripple, Sand Gut, Wolf Shoal, Wolf Creek, Buck Creek Shoal, Marrowbone Creek, Lick Creek, Stone Coal Creek, Jennie's Creek Shoal, Crums Mill Dam, Big Elk, Bull Shoal, Calf Creek Shoal, Whitt Bar, Endicotts Ripple, Camp Creek, John Smith Shoal, Twisting Shoal, Coon Creek, Falls of Tug, and between these points.

The principal work done, however, was at Yoces Sluice, where the walls had been torn down. These were well repaired and replaced, and the chute cleaned.

The work done was as follows:

Snags removed		70
Trees removed		19
Stumps removed		45
Trees topped		1
Solid rock excavated	cubic yards	215
Loose rock excavated	do	1,280

The cost of the work, including explosives, etc., was $672.86.

Work required to complete and maintain the existing project.—Above the mouth of Pigeon Creek but little work need be done except for the interests of rafting. The railway carries most of the local commerce. It will be necessary now and then to straighten and clean the boat chutes, but outside of the merest repairs, nothing will be required until a slack-water system is provided.

Below Pigeon it will still be necessary to maintain the river in good condition for

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steamboats and push boats as well as for rafts. It may be said that the original improvement, as contemplated, has been practically completed, but its maintenance will require more or less work each season to keep the shoals clean, the walls in repair, and the channel obstructions, forming each spring, removed.

Nothing further can be done until funds are available. When such is the case, it is proposed to remove all channel obstructions, repair the walls and wing dams, and put the river in safe condition as far up as Sycamore Creek, the head of steamboat navigation.

It is also proposed, if sufficient funds are appropriated, to put the upper part of the river, between Sycamore and the "Roughs," in better condition, and remove some of the old cobblestone dams which are not now in use.

An appropriation of $2,000 will do all the work considered necessary.

Respectfully submitted.

B. F. THOMAS, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 18.

IMPROVEMENT OF LOUISA (LEVISA) FORK OF BIG SANDY RIVER, KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, to July 31, 1897, and of Maj. William W. Harts, U. S. Volunteers, First Lieutenant, Corps of Engineers, from July 31 to August 31, 1897.]

The project for the improvement of this stream, adopted in 1880, provides for removing snags, rocks, overhanging trees, and forming low wing dams of loose stones at shoal places, to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push boat, and raft navigation. The characteristics of the stream are described in the following-named Annual Reports of the Chief of Engineers: 1875, pages 756–769; 1876, pages 140–146; 1884, pages 1755–1756; 1887, page 1902; 1888, pages 1795–1798; 1889, pages 1990–1994, and 1896, pages 2320–2321.

The most dangerous obstructions were removed at Georges Creek; but otherwise no work was done on this stream during the year, owing to lack of funds. A dike is needed at or near Georges Creek.

An estimate of cost and full report of the further improvement of this stream by locks and dams was submitted by me under date of April 27, 1898, printed as House Doc. No. 456, 55th Congress, 2d session.

A report in detail by Mr. B. F. Thomas, resident engineer, is herewith.

Money statement.

July 1, 1897, balance unexpended	$94.07
June 30, 1898, amount expended during fiscal year	68.50
July 1, 1898, balance unexpended	25.57
Amount that can be profitably expended in fiscal year ending June 30, 1900 (of which $1,500 is for maintenance). Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	11,500.00

Appropriations.

June 14, 1880	$2,500	July 13, 1892	$2,500
March 3, 1881	2,000	August 18, 1894	2,500
August 2, 1882	5,000	June 3, 1896	1,000
July 5, 1884	5,000	Total	26,750
August 5, 1886	3,750		
September 19, 1890	2,500		

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Commercial statistics for calendar year ending December 31, 1897.

Timber	tons..	150,000
Ties	do...	20,000
Staves	do...	500
Tan bark	do...	300
Miscellaneous	do...	50,000
Total	do...	220,800
Passengers	number..	10,000

The tonnage is largely governed by the draft of water and has not changed materially for five years.

REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mahan, Pa., June 30, 1898.

MAJOR: I have the honor to submit the following report concerning the improvement of Louisa [Levisa] Fork of Big Sandy River for the fiscal year ending June 30, 1898.

Characteristics.—The Levisa Fork is the principal tributary of the Big Sandy River. It rises in the Cumberland Mountains and flows northerly to its junction with the Tug Fork, where the Big Sandy is formed. It is navigable by steamboats of small size for 100 miles. The season of navigation will probably average four months a year for a distance of 87 miles and six months for 50 miles. During the low-water season commerce is transported by push boats.

Original condition.—Previous to the commencement of improvements on this river the channel was badly obstructed by snags, trees, rocks, etc., and the shoals were irregular and difficult of ascent or descent owing to the crookedness of the chutes or even the absence of chutes. The bends were rendered unsafe at certain stages because of projecting rocks of immense size off of which it was often impossible to keep timber rafts. Overhanging trees added to the danger of steamboat navigation, and taken altogether it was always at some considerable risk that navigation was carried on, particularly after nightfall. Even at a good stage of water navigation was unsafe on account of the liability to run onto hidden obstructions. The maximum width of the channel did not exceed 30 feet at a mean low-water depth of 1 foot. While the river in that condition was not even a fairly good waterway, yet it was utilized as the best means available, there being no railroads in that section at that time.

Plan of improvement.—The project for the improvement of this stream, adopted in 1880, provides for removing snags, rocks, and overhanging trees, and forming low wing dams of loose stones at shoal places to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push-boat, and raft navigation. The general plan of carrying on the work adopted has been to send out, during the low-water season, small, light-draft push boats with limited accommodations for a crew of from twelve to twenty-five men and for storing sufficient explosives, tools, etc. A simple hand crab is provided for use in pulling the boats over shoal places and occasionally for removing a snag or tree.

The removal of snags, trees, stumps, etc., is generally accomplished with dynamite, but as the water is usually at its lowest this can frequently be done with axes. All bowlders and loose stones are removed from the chutes in the shoals and piled up alongside in ridges called walls, the purpose of which is to confine the water. These walls have connection with the bank, and, at a steamboat stage, are generally submerged to such an extent as not to be in the way. Formerly wing dams were built of timber and stone at many of the worst places, and while most of these have decayed and gone to pieces, the more important ones have been repaired at intervals and are still of service to navigation. While none of the regulating improvements may be called permanent in character, yet they have been and are still of incalculable benefit to the river interests, and will, if maintained, answer the purposes of navigation until a better system (canalization) can supply the deficiency. Even then their usefulness will not cease, as they will guide and control the channels at such times as the dams can not be kept up.

Results and advantages.—Work under the project has been continued from time to time with small appropriations, and the river has been brought to almost as good a navigable condition as is possible without slack-water improvement. The steamboat channel has been kept clear of obstructions and the walls of the push-boat chutes have been kept in repair. The shoals have been cleaned, chutes straightened, and the water confined. At mean low water boats drawing 20 inches have

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found no difficulty in making their trips. In extreme low water only push boats having a draft of less than 1 foot have been successful.

Operations.—Owing to lack of funds, the only work done during the year was the removal of some large trees just below Georges Creek, 15 miles above Louisa, which had formed dangerous obstructions at that point and wrecked the steamer *Favorite* a year or more ago. This place has been remedied very materially. Cost for year, $68.50.

Work required to complete and maintain the existing project.—The most important work, without doubt, remaining to be done is the construction of a dike at Georges Creek, mention of which was made in the Annual Report, Chief of Engineers, 1896, pages 2321–2322. This improvement was recommended by me in letter of May 1, 1896. There is urgent necessity for this improvement. Work similar in character will be required at Middle Creek, 52 miles above Louisa. At Buffalo it will be necessary to remove a rock bar at no distant date.

Surveys of these points were recommended in my annual report for 1896, and the recommendation was renewed in the report for 1897. Aside from the points named, there are necessary minor repairs to neglected walls, removal of channel obstructions which have formed since work ceased, and removal of rocks from shoals.

Operations contemplated for the fiscal year ending June 30, 1899.—Should further funds, which do not definitely specify place of expenditure, become available, it is proposed to make a general cleaning up of the channel and repair existing chute walls. This work is urgent, so little having been done for the past two years.

The work mentioned above, at Georges Creek, will also be undertaken, provided funds are made available.

For the first work $3,000 should be appropriated; for the last, as heretofore recommended, $10,000.

Respectfully submitted.

B. F. THOMAS, *Resident Engineer.*

Maj. W. H. BIXBY,
Corps of Engineers, U. S. A.

F F 19.

PRELIMINARY REPORT ON SURVEY OF OHIO RIVER FROM MARIETTA, OHIO, TO PITTSBURG, PA., WITH A VIEW TO IMPROVEMENT BY MOVABLE DAMS TO PROVIDE A DEPTH OF 6 FEET AT LOW WATER.

[Printed in House Doc. No. 241, Fifty-fifth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1898.

SIR: The river and harbor act of June 3, 1896, contains an appropriation for improving Ohio River, and provides that $25,000 of the amount appropriated may be expended in a survey of the river from Marietta, Ohio, to the city of Pittsburg, Pa., to ascertain the number of movable dams necessary to improve the river between the points mentioned to provide 6 feet of water at low water, and the proper location of the necessary dams, as well as probable cost thereof.

The survey thus provided for was assigned to the officer in charge of the improvement of the Ohio River, and I have now the honor to submit the inclosed preliminary report of January 10, 1898, on the subject by Maj. W. H. Bixby, Corps of Engineers, and to recommend that it be sent to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Major Bixby states that the main work of the survey has been completed and that the information gained is being platted, but while the office work will require several months, the data at hand are sufficient to indicate that such dams can advantageously be given a lift, or difference of level of adjacent pools, of from 6 to 8 feet, and a spacing of from about 4 to 15 miles; that the first dam (No. 7) will be located somewhere

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between Industry, Pa., and Georgetown, Pa.; that the others, Nos. 8, 9, 10, etc., will follow in regular order, commencing below Babbs Island, but their exact location can not now be determined; that the total number of dams (including No. 7) will be between thirteen and eighteen, according to lift and spacing; that the cost of each will approximate closely those already constructed or under contract, viz, $750,000, including $25,000 for purchase of sites, and that their safe and proper completion will therefore require an appropriation of $750,000 (including $25,000 for purchase of sites) for Lock and Dam No. 7, above Georgetown, Pa., and a similar average amount for each of the others below Babbs Island, making the total estimate of cost between $9,750,000 and $13,500,000.

Full and detailed report of the results of this survey, with estimates for each dam, will be submitted when the field work is further platted and the office work completed.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. W. H. BIXBY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, January 10, 1898.

GENERAL: The river and harbor act of June 3, 1896, authorized the expenditure of $25,000, or as much thereof as might be necessary, on this survey, and required a report on the number of movable dams necessary to improve the river between said points to provide 6 feet of water therein at low water, and the proper location and the probable cost of said dams.

Pursuant to the above a survey was begun in the field September 17, 1896, under Mr. R. R. Jones, assistant engineer, and continued until November 30, 1896, when stopped by high water and winter weather. This field survey was resumed June 22, 1897, and continued up to October 4, 1897, the main work having now been completed. The information thus gained is now being platted in this office, and such office work, which, however, will still require several months' time, will allow of the approximate location of all the necessary dams. The exact locations will, however, require further field work in the vicinity of each approximate location, such as the examination of the subsoil for its suitability for foundations, and of other local features which, in such cases, greatly influence the cost, service, and proper final utility of such structures. Until the latter work is done a definite location, even within a few miles, might result in useless duplication of work, great waste of money, and final annoyance, rather than assistance to the interests of navigation.

The information already in hand is, however, sufficient to indicate that such dams can advantageously be given a lift, or difference of level of adjacent pools, of from about 6 to about 8 feet, and a spacing of from about 4 to about 15 miles; that the first dam, No. 7, will then lie somewhere between Industry, Pa., and Georgetown, Pa.; that the others, Nos. 8, 9, 10, etc., will then follow in regular order, commencing below Babbs Island, Ohio and West Virginia; that the total number of

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the same (including No. 7) will be between thirteen and eighteen, according to the lift and spacing; that there are no special difficulties in the way of such constructions; that the cost of each will approximate closely that of the six dams already constructed, or under contract, just above them, namely, $750,000 each, including $25,000 for purchase of sites; and that their safe and proper completion will therefore require an appropriation of $750,000 (including $25,000 for purchase of sites) for Lock and Dam No. 7, above Georgetown, Pa., and a similar average amount for each of Nos. 8, 9, 10, etc., below Babbs Island, Ohio and West Virginia, making the total estimate of cost of this improvement lie between $9,750,000 and $13,500,000, according to the total number of dams found actually necessary.

Drawings, including profiles and plans of the river and detailed locations of each lock and dam, as well as more detailed estimates for each dam in detail, will be forwarded later, when the field work is further platted and the office work is completed.

Improved methods of work which may arise during the next ten years may authorize a reduction of these estimates of cost during the actual progress of work; while, on the other hand, unforeseen contingencies may somewhat increase such estimates, but it is believed that the above estimates are as close as it is safe to depend upon at present, so that the above approximate locations and estimates of cost are herewith submitted as a sufficient basis for questions of present appropriations.

Very respectfully, your obedient servant,

W. H. BIXBY,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

F F 20.

PLANS AND ESTIMATES OF COST FOR IMPROVING BIG SANDY RIVER, INCLUDING TUG AND LOUISA FORKS, WEST VIRGINIA AND KENTUCKY, BY LOCKS AND DAMS.

[Printed in House Doc. No. 456, Fifty-fifth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., May 5, 1898.

SIR: I have the honor to acknowledge receipt of concurrent resolution of the House of Representatives of April 13, 1898, agreed to by the Senate April 14, authorizing and directing the Secretary of War "to prepare and submit more complete plans and estimates for the improvement of the Big Sandy and the Tug and Louisa forks of same, in Kentucky and West Virginia, with probable cost of same; and also to submit to Congress information as to whether this proposed extended improvement should be made."

In answer to the reference of the resolution to this office, I have the honor to submit the accompanying copy of report of April 27, 1898, by Maj. William H. Bixby, Corps of Engineers, the officer in charge of the improvement of these streams, from which it will be seen that permanent and satisfactory improvement can be effected only by the construction of locks and movable dams, and, in his opinion, the natural

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wealth of this river basin, with its enormous coal deposits as yet undeveloped through lack of proper transportation facilities, will amply justify the thorough improvement of this river. He states that such thorough improvement, based on the experience already gained, will require the construction of 10 locks and dams on the Louisa Fork between Louisa and Pikeville, Ky.; 8 locks and dams on the Tug Fork between Louisa and the mouth of the Pond, and 3 locks and dams on the main river between Louisa and Catlettsburg, Ky., or 21 locks and dams in all, and the work already done upon the one dam now completed at Louisa indicates that the construction of such locks and dams will involve no special engineering difficulties if the funds be promptly provided therefor. He estimates the cost of these locks and dams, including embanking, retaining, riprapping, and paving of banks, purchase of sites, lock employees' houses, storehouses and other buildings, dredging approaches to locks and passes, dredging shoals and removing obstructions between dams, etc., at an average of $225,000 each, or $4,725,000 in all.

Major Bixby's views regarding the rate at which appropriations should be made are given in his report, and if the improvement of these streams is to be undertaken, his remarks on this subject are worthy of the careful consideration of Congress.

The concurrent resolution is herewith returned.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. W. H. BIXBY, CORPS OF ENGINEERS.

CINCINNATI, OHIO, *April 27, 1898.*

GENERAL: In response to House resolution No. 25, Fifty-fifth Congress, second session, dated April 13, 1898, as concurred in by the Senate April 14, 1898, I herewith report as follows as to the propriety of an extended improvement of the Big Sandy River, including its two forks, the Tug and the Louisa, Kentucky and West Virginia, with plans and estimates and probable cost of same.

The Big Sandy is formed by the confluence of the Louisa and Tug forks, 26 miles from its mouth. It flows in a northwesterly direction through a narrow valley between rocky hills, and empties into the Ohio at Catlettsburg. Its bottom lands, varying in width, lie about 50 feet above low water, and are generally not subject to overflow. Its banks, except where the rocky hills immediately border the river, are composed of fine sand, easily washed by the current, and its many small tributaries are all sediment bearing during the rainy weather season.

The Louisa Fork is the larger of the two streams that unite to form the Big Sandy. It rises in the southwestern part of Virginia, at an elevation of about 1,500 feet above high water, and flows in a northwesterly direction. Its banks in many cases are rocky, in others composed of sand and clay. It has all the characteristics of a mountain stream, with a steep average slope, and with pools of varying depth separated by rocky bars which in low water often have but a few inches of water over them. Its average fall from Pikeville to Louisa is 1.54

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feet per mile, the distance between those points being 86.5 miles, and the total fall being 133.75 feet.

The Tug Fork rises in the mountains of McDowell County, W. Va., and flows in a northwesterly direction. Its general features are like those of the Louisa Fork, its pools being separated by rocky bars. Below the falls of the Tug, however, its pools are gradually filling up, so that in this locality the drop, formerly 3.55 feet in a stretch of 300 feet, was found in 1884 to be only about 0.50 foot. Its average fall from Pond to Warfield is 1.96 feet per mile, the distance being 23.50 miles, and its average fall from Warfield to Louisa is 1.72 feet per mile, the distance being 34.50 miles, its total fall from the mouth of the Pond to Louisa being 105.50 feet.

The only way of securing a sufficient depth of water for purposes of navigation, especially for navigation by coal barges, is to canalize this river and its forks by means of locks and dams.

In 1878 a project (see Annual Report Chief of Engineers, 1875, pp. 756–769) for "improving Big Sandy River from Catlettsburg, Ky., to the head of navigation," provided for the removal of rocks, snags, overhanging trees, and other obstructions from the main stream and also from both its forks, the Tug and the Louisa, above their confluence at Louisa, Ky., to aid the light-draft steamboat, push boat, and rafting navigation of this river, and under this project and appropriations therefor this river has been improved regularly, the main river from 1878 to 1880 and the forks from 1880 up to the present time.

By river and harbor act of June 14, 1880, $50,000 was also appropriated for beginning the construction of a lock and fixed dam at Louisa, and subsequent acts appropriated the funds required for its completion, the substitution of a movable for a fixed dam being specially authorized by the river and harbor act of July 13, 1892. This lock and dam is now completed and in operation.

By river and harbor act of August 11, 1888, an examination was ordered of the Big Sandy River from Catlettsburg to Pikeville on Louisa Fork and to Pond Creek on Tug Fork. Acting under orders dated August 28, 1888, Maj. D. W. Lockwood, Corps of Engineers, on January 10, 1889, made a report recommending the improvement by locks and dams and an estimate therefor, which report and estimate may be found on page 1990, Chief of Engineers' Report for 1889. The number of dams provided for in this report was 18 in addition to that since built at Louisa.

The lock and movable dam were opened to navigation over a year since and have been operated with marked success, and it has been demonstrated that a movable dam of this form is well adapted to this stream and can be maneuvered with sufficient facility to meet all conditions liable to arise. The pool can be kept full at the lowest stages.

A single dam in a river similar to the Big Sandy can be of small advantage, because for a great part of the year the water is too low elsewhere for satisfactory navigation. The lock and dam just completed was built largely for the purpose of determining whether or not this type of dam was suitable for use in the improvement of a stream of the character of the Big Sandy. The benefit from this one dam can be only local. It forms a pool for 9 miles up Louisa and 6 miles up Tug forks, in which coal can be loaded into boats and held until a sufficient rise comes to let the barges out into the Ohio, and it also may be, and is, used for the transportation of coal and farm products for the supply of the towns of Louisa, Ky., and Fort Gay, W. Va.

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With other dams below and above, the benefits to navigation would be very great and of a permanent nature.

As has been pointed out in several of the reports of the Chief of Engineers, above this dam lies a splendid undeveloped coal field which only awaits reliable water transportation to carry it to the markets along the Ohio. This coal, it is believed, will be developed as fast as the slack water reaches it, regardless of the improvement of the river below Louisa, because the pools formed by the slack water will give sufficient water in which to load barges during the low-water season and to hold them till there is a suitable stage for going out, as is now the case on the Great Kanawha and Monongahela. The improvement of the lower river, the Big Sandy itself, will enable these loaded boats to reach the Ohio at all times when there is sufficient water on that stream to float coal, and it should speedily follow or be done simultaneously with that of the two tributaries, Louisa and Tug forks; but no good reason is apparent why it should precede the improvement of the forks, as it will only assist the improvement of the present commerce without increasing it appreciably.

Permanent and satisfactory improvement can only be effected by the construction of locks and movable dams. On account of the great quantities of sand and drift afloat on all rises, the pools formed by fixed dams are liable to fill up and snags to be deposited so as to render navigation difficult and hazardous. But the success of the dam already built at Louisa, as well as that of other movable dams on the Ohio and Great Kanawha rivers, demonstrates beyond doubt that this method of improvement is well suited to the demands of the navigation of this river, and that although at first costly, it is in the end the most advantageous yet known for such cases. In my opinion, as well as that of my predecessors, Majors Lockwood and Gregory, the natural wealth of this river basin, with its enormous coal deposits as yet undeveloped through lack of proper transportation facilities, will thoroughly justify the thorough improvement of this river. Such thorough improvement based on the experience already gained will require the construction of 10 locks and dams on the Louisa Fork between Louisa and Pikeville, Ky., 8 locks and dams on the Tug Fork between Louisa and the mouth of the Pond, and 3 locks and dams on the main river between Louisa and Catlettsburg, Ky., 21 locks and dams in all. As proved by the work already done upon the one dam now completed at Louisa, the construction of such locks and dams will involve no special engineering difficulties if the funds be promptly provided therefor.

In fuller explanation of the wealth of this river basin, its possible improvement by a system of movable dams, and the feasibility and advantages of the same, I inclose herewith extracts from a special report prepared last year by Mr. B. F. Thomas, the resident assistant engineer in local charge of this river improvement.

The dam already constructed on this river at Louisa is so satisfactory in all ways that it is proposed to adopt the same general plan of dam for the rest of the river, lowering its lift at the mouth of the river, but raising it, where practicable, at other places to 12 feet, and reserving, moreover, the right to modify the construction of its movable parts as may later be found desirable in order to keep up with the progress of invention between now and the date of actual future construction of these dams. For the plan and details of the Louisa dam, thus adopted as the general model, see pages 2534–2560 and accompanying plates 1 to 15 of the Annual Report Chief of Engineers for 1897. It is proposed to give to each of the new dams a height of from 12 to 18 feet, a navi-

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gable pass of 100 feet least width and 4 feet least depth at the upper end of the forks, and of 150 feet least width and 6 feet least depth at the lower end of the river; a lift from pool to pool of from 6 to 12 feet; a lock of at least 255 feet total length, and of at least 52 feet clear width (wide enough for two barges abreast), with a depth at least equal to that of the navigable pass; and a weir across the rest of the river rising 6 feet or less above the sill of the pass, so as to be entirely submerged at all high stages of the river.

The cost of construction is estimated as follows:

Near the lower end of the river, for a lock 255 feet long, 52 feet wide; dam 18 feet on pass sill, 12 feet on weir sill; pass 150 feet long; weir 160 feet long:	
Lock, including cofferdam, excavations, foundations, masonry, timber and iron work of fixed and movable parts, machinery, and accessories	$122,000
Pass, weirs, abutments; same items	84,000
Miscellaneous, including embanking, retaining, riprapping, and paving of banks, purchase of sites, lock employees' houses, storehouses, other buildings, dredging of approaches to locks and passes, dredging of shoals and removal of obstructions between dams, surveys and other engineering work of location, construction and inspection, office work of engineering and disbursements, and other contingencies	44,000
Total	250,000
Near the upper end of the forks, for a lock of the same length and width, same height on pass and weir, but with pass of 100 feet length and weir of 120 feet length:	
Lock; same items as before	76,000
Pass, weirs, abutments; same items as before	50,000
Miscellaneous; same items as before	34,000
Total	160,000

These estimates are based on past experience on this river, gained in the construction of the existing dam at Louisa. The cost will average about $225,000 per dam for the 21 dams, making a total for the completely finished improvement of $4,725,000.

These dams as above proposed will be separated by distances averaging 9 miles per dam, but the exact location in site of each dam will depend on so many local conditions, as to the soil under the river and on its banks (affecting foundations and abutments), as to the actual extent, location, and material of the adjoining river bars (affecting dredging), and as to the location and width of river channels just above and below (affecting approaches), that the exact locations of sites can not be made until after further special detailed surveys, one for each lock and dam, which special survey should precede the purchase of sites at each place, the cost thereof being included in the above estimates.

For the most economical prosecution of the work appropriations should be made at the rate of $10,000 per lock and dam ($210,000 for the 21 locks and dams), to be immediately available, so far as found necessary, for the purchase of sites, including the detailed surveys needed for their exact location, the unused portions to be later available for work of actual construction.

After this, further appropriations for one lock and dam near the coal fields of each fork and one near the mouth of the main river should be made at the rate of $225,000 per lock and dam. Further appropriations should then follow at slightly lessened amounts per dam on the upper rivers and increased amounts per dam on the lower river. Appropriations of less than the above are liable to increase the final cost of the work.

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For most advantageous work to the river commerce, the locks and dams to be first constructed should be built in the order above suggested, and simultaneously on both forks and the main river, after which the order of further construction should depend upon further development of commerce.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 17, 1897.

MAJOR: By letter from your office dated June 12, 1897, I am directed to report "whether the extension of slack-water navigation, especially up the forks (of Big Sandy River), would result in developing the coal fields, etc., to an extent that would fully warrant the necessary expenditure; how many mines are now in operation, their location, output, capacity, width of vein, quality of coal," etc.

In compliance with the foregoing, I have the honor to report:

As the characteristics of each fork are practically the same, they will be reported upon together.

PRESENT IMPROVEMENT.

That part of Lousia Fork lying between Louisa and Pikeville, 86½ miles, has been reported as worthy of improvement by locks and dams. It is navigable more than half the year by steamboats. It has been fairly well improved by the cleaning of shoals, blasting of rocks, removal of channel obstructions, and the confining of the chutes, and these improvements have been well maintained, to the great advantage of the river interests. Of late years the caving of the banks has given trouble at several points, notably Middle Creek, 52 miles above Louisa, and Georges Creek, 15 miles above Louisa. Some difficulty has been experienced at Buffalo, 33 miles above Louisa, with a rock bar. Outside of these points the river may be said to be in as good navigable condition as it is possible to keep it without a slack-water system.

On Tug Fork the river has been kept in good navigable condition by the same character of improvements as those of the Louisa. Steamboats run to Pond Creek, 58 miles above Louisa, on good stages of water, and push boats can run at other times, and the river has been reported as worthy of improvement to this point.

CHARACTER OF COUNTRY.

Between Louisa and Pikeville, on Louisa, and Pond Creek, on Tug, the country is mountainous, and, while the bottom lands are fertile, the hills are poor. They have been cleaned up and cultivated until much of the soil has washed into the river. New lands are constantly being opened up, and the farms have been extended from the river to the heads of the smallest tributaries. The timber has been largely cut off and run out to market, although well back from the river may still be found thousands of acres of fine poplar and oak trees, with a fair percentage of black walnut.

COAL.

The wealth of the Big Sandy Valley is not now in its farms or its timber, but in its coal. There is scarcely a hill in which may not be found at least one good vein of coal and in many sections several veins exist. Most of this is of good quality, and the beds are of workable thickness. The Peach Orchard vein, which has been mined at Peach Orchard, 16 miles south of Louisa and shipped by rail for many years, has a thickness of from 4 to 5 feet. The output varies from 100 to 400 tons per day. It is a remarkably pure coal and stands handling and stocking with scarcely any loss. It was first opened before the war and shipped by river, but without an improved river the loss of boats was too great for profitable mining. The railroad was then built to it, and it now constitutes the chief traffic of 50 miles of railway. This vein may be found on nearly all the land lying between Louisa and Tug forks.

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The McHenry vein has been opened and a considerable mining town started at Torchlight, 5 or 6 miles south of Louisa, on the Louisa Fork. The coal is of a superior quality, but its extent is not well known. The cost of transportation by rail has prevented its development, but now that slack water has reached it it is believed that mining will be carried on extensively.

At White House, 26 miles from Louisa, extensive mining operations have been carried on for several years in the cannel-coal field. It is transported by rail, the market being largely in Chicago, where it is used as a gas purifier. The operations are just now being extended on to Greasy Creek, which empties into the Louisa at a point 30 miles above Louisa, and a railroad is nearing completion into the new territory. The cannel coal is of splendid quality and finds a ready market, although it has not been as largely mined as would have been the case with better transportation facilities. Above this point there are no means of transportation for coal, and while both soft and cannel coal are abundant in area, excellent in quality, and of ample thickness of bed, yet nothing can be done with it until there are safe and certain facilities for its removal. Its development is certain when a slack-water system has been assured.

On Tug Fork, outside of a few small mines for local consumption, no mines have been opened, because of the lack of transportation facilities. At Warfield, 35 miles above Louisa, coal was mined many years ago and the vein is large and regular and of excellent quality. It is known that it can be profitably mined in immense quantities whenever transportation can be had for it. Some 30 miles farther up the Tug Fork, at Thacker, W. Va., is one of the largest coal operations along the new line of the Norfolk and Western Railroad, and that vein also exists on the Kentucky side of Tug Fork. At the mouth of Pigeon Creek, 40 miles above Louisa, there are several veins of excellent coal, which it is proposed to soon begin working, I am informed. Six or 8 miles above Louisa some prospecting has been done, and I was told some time since by the owner that it was his purpose to mine and ship this coal as soon as slack water reached the place. He told me that he had at least two veins of workable thickness and of excellent quality, which could be operated at a profit on slack water. Rock Castle Creek empties into Tug at a point 10 miles above its mouth. This creek and its tributaries form one of the best coal fields in the valley. An eastern company has prospected extensively on the Middle and Rockhouse forks of it, and in 1882 I measured the coal in many of the numerous openings made by them up to that time. The aggregate depth of coal was over 40 feet and the veins ranged from 3 feet to 11 feet in thickness.

It would be necessary to bring this coal by rail to the river, the same as is done at several points on the Great Kanawha. Each of the forks has several large tributaries, upon which there is an abundance of good coal and the quantity immediately along the river is quite large. If but one vein be counted as profitably workable, there would be tributary to slack water reaching to Warfield, on Tug Fork and Prestonsburg, on Louisa Fork, a distance of 35 and 52 miles, respectively, something near 500,000 acres of actual coal land. Even greater quantities exist above those points.

The Kentucky geological report for 1884 has the following on the eastern Kentucky coal field in this vicinity:

"Above the conglomerate sandstone is a coal bed which, from its wide range and its quality, will prove one of the most valuable in eastern Kentucky. It appears to be the equivalent of the Jackson-shaft coal in Ohio. It is exposed on all the upper branches of Blaine Creek and on Little Blaine and Georges Creek, where it is opened at several points. At Warfield, on Tug Fork of Sandy, it is the main coal, and is near high-water mark. At Flat Gap, in Johnson County, this coal is found in good thickness near the base of the hills. It is near high-water mark at Prestonsburg, on Louisa Fork. In thickness this coal (No. 1) varies in different sections, but so far as developed it has a local uniformity which promises to make mining easy and profitable. On Georges Creek and at Warfield it has a thickness of 5 feet. At all these points it is without any considerable parting. It ranks with the best coals, as will be seen from the analysis of Professor Peter and Mr. Talbutt:

	1.	2.
	Per cent.	*Per cent.*
Specific gravity	1.269	.....
Moisture	3.50	3.60
Volatile combustible matter	36.00	35.40
Fixed carbon	57.30	57.60
Ash	2.20	3.40
Sulphur	1.148	1.108

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"The Jackson shaft coal has already acquired considerable reputation as an iron-making coal. The Warfield and Prestonsburg coals appear to be fully an average in quality, while considerably increased in thickness.

"McHenry's coal, 6 miles south of Louisa, and the main Peach Orchard coal (No. 3) are respectively 170 and 200 feet above the bed of Big Sandy. One-half mile below Rock Castle Creek, on Tug Fork, this coal shows at 175 feet.

"This coal varies in thickness, being 3 feet on Blaine and 6 feet at Peach Orchard, including three thin partings. M'Henry's bank shows 4 feet 4 inches, including two thin partings.

"The analysis is as follows:

	Per cent.
Moisture	3.24
Volatile combustible matter	36.56
Fixed carbon	54.95
Ash	5.24
Sulphur	1.189

"Coal No. 7, or Coalton coal, has acquired a wide reputation as an iron-making coal. Its thickness is from 3½ to 6 feet, in two or three parts of about 2 feet each, the upper part disappearing when the bed is less than 6 feet. The partings are remarkably regular and have a thickness of from 1 to 3 inches. This coal is more widely known as an iron-making coal than any other bed in eastern Kentucky, being used without coking with marked success.

"This coal has not been opened on Big Sandy except near Louisa and on Muddy Branch of Blaine. Coal No. 8 is seen along the Big Sandy at a number of points, and on Tug Fork. It is inferior in quality to No. 7, and has therefore been opened in but few places."

From a report made by John Christopher in 1872 on the coal and iron ore between Tug and Louisa forks near their junction, the following is extracted:

"The examination extends from junction to Contrary Creek (9 miles) on Louisa, and to Rock Castle (10 miles) on Tug Fork. There are three veins of iron ore and three veins of coal. The top hill vein of ore is 12 inches and is a brown hydrate about 40 per cent iron; the next descending is a brown oxide and varies from 4 to 18 inches in thickness, and will yield from 55 to 60 per cent in a blast furnace; the lower vein is a gray carbonate 16 inches thick and will yield 40 per cent metallic iron, and is the same as the gray carbonate at Bradys Bend on the Allegheny River. I think this vein when fully developed will be from 3 to 4 feet. I found the crop of two other veins of block ore, such as runs through the entire Hanging Rock region in Ohio.

"There are two workable veins of coal. The lower one is something over 3 feet and the second about 4 feet. They are both good coking coals, not entirely free from sulphur, but fair merchantable coal. A vein of cannel coal was also found in the bed of a run, from 4 to 5 feet thick. It is bright and clean, although it has been exposed to the action of air and water for centuries. I burned some of it and found it contains a large amount of gas. It ignites very easily, will burn in a candle, and I think is a valuable coal. I found the crop of three other veins, and I think the Coalton vein is here.

"The quality of the Coalton and Peach Orchard coal is very superior. They are now running a large blast furnace at Ashland on the Coalton coal and are making an extra quality of iron and a very large amount, much greater than other furnaces of same size on other coal. The Peach Orchard coal is remarkable for its great purity. You may handle tons of it and not find a trace of sulphur, and it will bear handling and stocking any length of time without injuring the quality and with very little loss.

"In 1860 I saw and worked several hundred tons of Peach Orchard coal in a blast furnace and made the best iron I have ever seen made from stone coal, and the wear upon the furnace is much less with this coal than with any other."

A copy of a report upon the Johnson County coal field by C. K. Lawrence, a civil engineer, who has carefully investigated the subject, is given below entire. This field lies immediately along the creeks emptying into the Louisa above the Greasy Creek field.

The report is as follows:

[Report of Mr. C. K. Lawrence, civil engineer.]

"COAL MEASUREMENTS IN JOHNSON COUNTY, KY., 30 TO 40 MILES ABOVE LOUISA.

"The following is report of coal as exposed at a number of openings on Greasy, Buffalo, Millers, and Daniels creeks, tributaries of Louisa Fork:

"It was impossible in some cases to get accurate measurements or make as close examination as desired, many of the openings having caved in and partially filled with water since the farmers mined their winter supply of coal.

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"I have designated openings, of which I took note by numbering them, and for their location reference can be made to numbers on accompanying map.*

"No. 1.—No. 1 vein; 40 inches of clean coal without partings; top half splint and balance block coal; about 50 feet above high-water mark (backwater from river).

"No. 2.—No. 1 vein; 46 inches of clean coal without partings; upper half of vein splint, balance block coal; about 40 feet above creek.

"No. 3.—No. 1 vein; 48 inches, same quality of coal as opening No. 2; about 40 feet above creek.

"No. 4.—Old opening fallen in. No. 1 vein; said to be 5 feet thick and same quality of coal as at No. 3 opening. It was abandoned and No. 3 opened on account of greater convenience.

"No. 5.—No. 1 vein in bed of creek where it goes under drainage and is about 36 inches thick, with opening a few hundred feet lower down; 42 inches of clean coal; same quality as Nos. 1 to 4.

"No. 6.—At the head of Two Mile Creek, about 75 feet under low gap between Two Mile and Sprague Fork of Buffalo Creek. Vein measures 50 inches at mouth of drift; think it is No. 4, the regular cannel vein. It is part cannel, but could not get to face of coal to measure thickness of cannel. From measurements of lump found outside, find the cannel must not be less than 24 inches; balance is block coal. It is a very fine vein of coal and is probably about 250 feet above the river and 250 to 300 feet of hill above it each side of gap. In this opening the block coal is over the cannel.

"No. 7.—Vein No. 1 where it goes under drainage on Greasy Creek side. Vein is 42 inches thick, as near as I could measure; said to be 48 inches; coal of same quality as shown at other openings of same vein.

"No. 8.—Vein No. 1; 20 feet above run, probably about 40 feet above high-water mark in river; 42 inches clean coal; no partings; splint and block coal, same quality as at other openings.

"No. 9.—Cannel coal vein; supposed to be the same as No. 6 opening; 54 inches thick; lower 26 inches cannel, balance splint and block coal.

"No. 10.—One-half mile from mouth of Greasy Creek; supposed to be No. 2 vein; 42 inches thick; about 4 to 5 inches cannel coal in bottom, balance fine block coal, which separates readily and will interfere but little with mining. Coal does not ignite as quickly as No. 1 vein, but lasts well and would make a very fine steam coal; analyses show it to be a fine coking coal. It is hard and will make a good coal for shipment. This coal vein is about 120 to 130 feet above high-water mark. No. 1 vein is opened at foot of hill at high-water mark; caved in at present, but reported to be about 3 feet thick. Between this point and mouth of Two Mile Creek No. 1 vein is opened at several places along the creek, about 25 feet above high-water mark, and is about 36 inches in thickness; one opening reported 42 inches; it is same quality as at other openings.

"No. 11.—Same vein as No. 10 opening; 48 inches thick; coal same quality; about 100 feet above creek.

"No. 12.—Two openings about 30 feet apart (vertically); one at point of hill and the other nearer bed of branch. The top vein is 48 inches and lower 42 inches, both same quality of coal as in openings Nos. 10 and 11, except that cannel coal does not appear in lower vein. The 1½-inch parting is the same in both. Lower vein about 75 feet above creek.

"No. 13.—Corresponds in quality and position in hill with the lower No. 12 opening, and the fact of this vein being exposed at three places within half a mile at same elevation indicates that it is a separate vein underlying the vein at Nos. 10, 11, and 12 openings. This vein is 42 inches thick; fine quality of coal. There is an opening on opposite side of Greasy Creek of same vein, said to be 48 inches in thickness. No. 1 is reported to be exposed in a well at this point a few feet below the bed of creek. Said to be 4 feet thick.

"No. 14.—On Hurricane Creek, about 100 feet above creek, is a vein 48 inches with 4 to 8 inches of cannel in bottom. Did not discover any partings. I think it is No. 2 vein, same opening as 10 and 11, the cannel-coal vein No. 4, same as openings 6 and 9, said to be opened 75 feet higher on hill, but is caved in.

"No. 15.—Opened about 12 feet above creek; 36 inches thick. No partings; think it is No. 1 vein.

"No. 16.—Caved in, but reported to be a fine quality of coal 4 feet thick. I think it is same as Nos. 10 and 11 from position in hill.

"No. 17.—On Middle Fork, vein 4 feet thick. It is reported to be free from partings; could not make examination. It is about 75 feet above creek, and may be No. 2 vein, although it seems too high. The creek rises from 50 to 75 feet from forks, which, with the apparent pitch of strata in opposite direction, would indicate that No. 2 was under drainage at this point. It may be No. 3, but does not appear thick enough for that vein.

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"No. 18.—This vein shows only the outcrop. It would have to be driven back several feet to roof rock to ascertain thickness, quality of coal, etc.; the outcrop shows 5 feet in thickness, and indications from blossom above are that it will increase to at least 7 feet when driven back to roof rock. I think it is No. 3, the same vein that shows up on Daniels Creek at opening 24, and is also exposed on opposite side of ridge in Martin County, on Rockhouse Fork of Rock Castle Creek.

"No. 19.—No opening. Outcrop in edge of creek; about 20 inches of slate, which burns almost as well as cannel, and 4 inches of block coal. It is about 20 feet under vein shown in opening No. 18. Do not consider it of any value.

"No. 20.—Vein near top of hill at head of Middle Fork. It is not driven into roof rock, but indicates vein of about 12 feet in thickness. It is too close to top of hill to be of any use, having but a few acres of covering.

"No. 21.—Near mouth of Middle Fork; caved in, but reported by party who opened it to be 39 inches thick—25 inches cannel and 14 inches block coal. If this is true, it is the same vein as at openings 6 and 9, and would indicate that cannel extended through to this point. Its location in hill, however, indicates it to be No. 2.

"No. 22.—About 150 feet to 175 above creek, 4 feet thick. Although not thick enough, its position in hill indicates it to be No. 3 vein. No partings reported. Could not examine face. The coal taken out is a very fine quality. Small 20-inch vein near creek, which may be No. 1, although quality of coal indicates it to be one of the small veins overlying No. 1 vein.

"No. 23.—On Daniels Creek, 62 inches in thickness; 12 inches at bottom is cannel, balance being hard block coal. Could not find any partings, although the upper part sloped off considerably, and being partially covered with mud, there may be a small parting corresponding to No. 2 vein elsewhere, as it is believed to be that vein; it is about 50 feet above creek.

"No. 24.—Outcrop faced up but not driven into roof rock; 8½ feet thick. I think there is a parting of about 6 inches 6 feet from bottom, and possibly other small partings, but not driven in far enough to ascertain positively. I think this is No. 3, and the same vein opened at No. 18 on Middle Fork of Greasy Creek and the same that is reported in the head of Rockhouse Fork, opposite side of the ridge. The same vein on the same hill, near the bed of stream.

"No. 25.—Vein 9 feet thick, with parting about 6 feet from bottom, same as opening No. 24. On opposite side of ridge from the opening the same vein shows 11 feet when driven in far enough to show full thickness; also near top of ridge an opening showing seam 13 feet in thickness, evidently the same vein as No. 20, but too high to be of much value.

"No. 26.—Vein only 4 or 5 feet above surface water, 50 inches thick, and a very fine coal for blacksmithing, indicating to be a good coking coal. I think it is one of the thin veins underlying No. 2, and which here reaches a good workable thickness.

"No. 27.—On Millers Creek, about 200 feet above creek, vein is 7 feet thick with one parting (hard slate) of about 5 inches, 1 foot from bottom; three more thin partings, but they appear to work out as opening is driven into hill; fine quality of coal, splint and block. Think it is No. 3 vein, same as opening No. 24, on Daniels Creek.

"No. 28.—Same as No. 27, 6 feet thick.

"No. 29.—Same as No. 27, 7 feet thick with one parting of fire clay 6 inches thick; parting about 1 foot from bottom.

"No. 30.—About 50 feet lower in hill than No. 3 vein, and is probably No. 2. Said by natives to be a very fine quality of coal for domestic and blacksmithing purposes. Vein about 4 feet thick without partings; evidently a fine coking coal.

"Nos. 31 and 32.—No. 3 vein, 7 feet thick, same as No. 29.

"No. 33.—Same as No. 30, 46 inches thick; 215 feet above creek; no partings; very fine coal.

"No. 34.—No. 1 vein, 5 feet above creek; 4 feet thick. This is a fine splint and block coal, same quality as is shown on Buffalo, Two Mile, and Greasy creeks. This opening has been driven into clean coal (about 75 feet); it shows up better than any of the other openings, being clean, hard, and free from rust.

"No. 35.—No. 1 vein; 5 feet thick; same quality as No. 34; opening is not being worked at present. This vein is thicker at this point than at any opening on the east side of the river; vein 25 feet above creek.

"No. 36.—No. 1 vein; 4 feet thick; 45 feet above creek.

"No. 37.—No. 1 vein; 42 inches thick; 60 feet above creek

"No. 38.—No. 1 vein; goes under drainage on Millers Creek side.

"No. 39.—No. 1 vein; goes under drainage on right fork of Buffalo Creek. No. 1 vein is opened at several places between mouth of Buffalo and Millers creeks, along proposed route of road, and in each case shows about 3½ feet of coal. The openings, 1½ miles below Paintsville, on west side of river, are about 95 feet above high water; vein from 4 to 5 feet in thickness, about 1 foot of top being splint and balance

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block coal. As this No. 1 vein goes under river about 1½ miles below Greasy Creek it shows a sharp dip to the northeast, and also dips to southeast, but not so rapidly. With the exception of No. 34, which is driven under hill about 75 feet, all openings examined are practically outcrops; many places vein was not faced up back to roof rock, while in no cases did drift extend over 15 to 25 feet under hill. This condition renders an examination very unsatisfactory, but as samples obtained showed coal to be of excellent quality we know that at a proper depth in hill the quality must be better and seam of greater thickness.

"QUALITY OF COAL IN DIFFERENT VEINS.

"No. 1 is classed as a splint coal, but I think some difference should be made. The top, and in some cases the upper half, mines in large slabs, the real splint formation, while the lower portion is more of a cubical formation and mines in blocks.

"The block coal does not have so much volatile matter as the splint, but is higher in fixed carbon and stronger for steam.

"The splint ignites almost as quickly as cannel and burns very much like it. The two qualities mixed, as they are in mining, make a very fine domestic and steam coal. There are no slate partings in this vein through section reported on, and very little sulphur, making one of the cleanest and purest coals I have ever seen. It is very hard and firm, and will make an excellent coal for shipment. I think it superior to anything in the Northwest market for any purpose, and I am confident it will make more steam or gas than the Youghiogheny, which is their standard high-grade coal. In a test made by the Kentucky Central Railway of Youghiogheny, Ashland, and splint (similar to this vein), the result of a month's trial of each is as follows:

"Consumed per mile:	Pounds.
Ashland	43
Youghiogheny	39
Splint	25

"The only practical tests we have of the vein at this point is that made by steamboats, the engineers of which pronounce it to be the finest coal they obtain anywhere. The following is analysis of this coal at four different points:

	First.	Second.	Third.	Fourth.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Volatile matter	40.70	41.70	35.20	39.266
Fixed carbon	56.30	53.50	63.80	57.74
Ash	3.00	4.80	1.00	3.00
Sulphur	1.291	.735	.....	.596

"No. 2.—This is only used at a few points where No. 1 vein is under drainage. It is reported by those using it to be a very fine domestic coal. It does not ignite as quickly as coal No. 1, but from what I have seen of it think it will make as strong a steam coal. From a test made from one of the openings on Greasy Creek, it gives very good results as a coking coal. The following is analysis of coke produced:

	Per cent.
Volatile combustible matter	3.60
Fixed carbon	89.40
Ash	7.00
Sulphur	.576

"This vein has from 4 to 12 inches cannel coal in bottom at many places. It also has a parting in some openings of 1½ inches of 'nigger head.' By channeling or bearing in at a point parting occurs, coal can be mined without mixing nigger head with coal.

"No. 3.—This is the same vein that is now mined at Peach Orchard, which is considered one of the finest qualities of coal in the market. This has from one to five partings at all points opened. I am informed that in the Peach Orchard mines vein ranges from 5 to 6 feet, including slate partings, but without partings leaves from 44 to 48 inches of clean coal. The expense in separating slate is considerable, and, with exception of main parting, which is cut out in mining, it is impossible to completely separate it. Openings between Buffalo and Millers creeks show vein to be 7 feet in thickness, with only one parting of about 6 inches, which is near top. In some instances on Daniels Creek vein is 8½ and 9 feet thick, but could not get exact thickness or number of partings. It is not opened on Greasy or Buffalo Creek. It is a very valuable vein for mining, especially where found with one or two partings.

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"The following is analysis of this coal:

	Per cent.
Volatile matter	37.48
Fixed carbon	55.36
Ash	7.16

"The present very high reputation of the Peach Orchard mine establishes the reputation of this vein of coal, but this vein has an advantage over that of Peach Orchard in that it is thicker and easier mined.

"No. 4.—This is a regular cannel-coal vein, and generally shows more or less cannel coal where opened. The only point at which I have seen it opened is on Two Mile and Buffalo creeks, and on the property of the United Coal Company, near East Point. The cannel coal is of very fine quality, and the block coal with it is also very fine, and I believe will prove to be a good coking coal. One opening on the United Coal Company's property shows 5 feet of cannel coal with 6 inches of block coal at bottom.

"At openings between Buffalo and Greasy creeks the vein is about 4½ feet in thickness, about one-half being cannel with block coal on top.

"This vein is opened at only a few points on the property in question, owing largely to the fact that little or no prospecting has been done. Present openings show it to extend through and along ridge between Greasy and Buffalo creeks, but no openings have yet been made in the vein on south side of Buffalo or Millers creek.

"Following shows analysis of this coal:

	Per cent.
Volatile matter	55.88
Fixed carbon	35.75
Ash	8.37

"This is a very valuable coal on account of its high grade, being one of a very few cannel coals carrying high enough percentage of volatile matter to be an export coal. Export coal must contain 50 per cent or more of volatile matter. Indiana, Ohio, and Pennsylvania cannels do not go over 44 to 46 per cent. For domestic purposes this is far superior to the cannel coals above mentioned, giving a much clearer and brighter flame, and does not snap and fly over the room, necessitating wire screens. The thickness of this vein will enable this coal to be mined for little over one-half the cost of the other mines in Kentucky mining the same grade, their veins being very thin.

"No. 5.—Is not regularly opened at any point. It is about 4 feet thick and is semicannel. While no analysis has been made, it is evidently a very superior coal for domestic purposes.

"No. 6.—Is probably not under 6 feet at any point, but know of no points where it has been driven to roof rock. The opening No. 20 is No. 6 or No. 7 seam—probably the latter. These seams are high and do not underlie much territory, but may be found of considerable value at certain points."

From another report by Mr. Lawrence the following extracts are taken:

"The present annual tonnage on Louisa Fork is summed up as follows:

High-class freight	tons..	55,000
Common freight	do...	100,000
Timber	do...	300,000
Passengers		40,000

"A much larger annual tonnage will immediately follow from development of coal, oil, and other resources, estimated as follows:

Coal	tons..	750,000
Timber	do...	150,000
Lumber	do...	150,000
Common freight	do...	150,000
High-class freight	do...	100,000
Passengers		50,000

"The increase in inbound business occasioned by opening mines, mills, and woodworking manufactories should more than make up the increase estimated in common and high-class freight. The principal and most favorable feature in the opening of this coal field is the cannel coal, which offers conditions with which no other coal field can compete. The operators in this field will be able to revolutionize the business in that kind of coal. The only high grades of this coal are found in Kentucky or in limited sections immediately adjoining. Its scarcity and the high cost of mining, owing to the thin seams, which are in many instances under 1 foot and rarely over 2 feet, have kept the price so high as to make it a luxury, the mass of consumers being unable to afford it for domestic purposes.

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"The greater part of the present output is used for enriching gas, much of it being exported for that purpose. In the Eastern cities the retail price ranges from $10 to $15 per ton, and in the Central and Western cities its price is about the same as anthracite, while the ordinary bituminous coal retails at less than one-half that amount.

"In this field the quality is as fine if not finer than is found anywhere in this State or in the United States, while the thickness of the seams, being from 3 to 6 feet, will enable the coal operators to mine it at about the same cost as ordinary bituminous. This will allow them to market it at a price so little above that of the ordinary bituminous coal that it will be within the reach of all and will be almost entirely used in open grates, which will make the demand for the coal enormous. The field lies in the central belt of the United States, where open grates are universally used for heating purposes. In fact, all the country lying south and for 300 miles north largely uses open-grate fires. Lower prices will also increase its use for gas purposes and export trade."

Above the points covered by the reports quoted I have but little published information, but it is well known that the coal is even better there than upon the lower parts of the rivers.

Attention is invited to the report of N. S. Shaler, on page 763, Report of Chief of Engineers, United States Army, 1875.

On Elkhorn Fork, above Pikeville, lies a large body of the famous Pocahontas coking coal, which can reach the slack water by railroad down Shelby Creek. On Mud Creek and at Laynesville, about 12 miles below Pikeville, and in fact at numerous points along the Louisa, excellent coal in great quantities is found.

Johns Creek, which enters the Louisa about 44 miles above its mouth, and is one of its longest tributaries, is rich in both coal and iron ore, as well as timber. Beaver Creek, emptying into Louisa 20 miles below Pikeville, also has the well-known Pocahontas vein. In fact every tributary has a good showing of coal, and few larger fields exist than can be reached by the Louisa and Tug forks and their tributaries.

GENERAL.

From the foregoing reports upon the quality of coal and extent of coal field, and from my own knowledge gained by a personal inspection of the territory adjacent to these two forks, and between them to the Virginia line, I have no hesitation in recommending their improvement by locks and dams as far as Pikeville, on Louisa, and the mouth of Pond on Tug Fork, and in saying that the improvements would be of sufficient benefit to warrant the expenditure. The development of the cannel coal at White House and Greasy, since Major Lockwood's report of 1889, only emphasizes the merit of the improvement proposed on Louisa Fork, and the development of coal mines along the line of the new Norfolk and Western Railroad on the upper Tug Fork but strengthens the proposition to lock and dam that river. If these coals can be mined and transported long distances over the heavy grades of the railroads on each fork at a profit, it is a great argument in their favor and only suggests what may be expected when reliable water transportation can be had.

While slack-water improvement in the two forks will undoubtedly develop a large coal trade, this navigation would be greatly benefited by the construction of works on the Big Sandy itself, and any project looking to the permanent improvement of the river should include locks and dams below Louisa and an improvement by regulating works at its junction with the Ohio.

* * * * * * *

While it may not be within the scope of this report to enter into the details of the locks and dams themselves, yet the suggestion is respectfully submitted that the dams be movable and of as great lift as is ordinarily given to fixed dams, and that the locks be of sufficient width to admit two barges abreast. The principal objection to movable dams on steep rivers has always been the great number required on account of the low lift possible. The present dam at Louisa sustains a head of 11 to 12 feet and is operated with as much speed and ease as are the low-lift dams elsewhere. Dams 16 to 18 feet in height with 4 to 6 feet on the lower sill would be but slightly heavier than this one and would ordinarily sustain no greater head, and the various parts can be maneuvered with perfect safety and great facility with inexpensive machinery designed for the purpose. The first cost of the system would thereby be reduced almost one-half, as would also the subsequent cost of operation and repairs. * * *

Very respectfully, your obedient servant,

B. F. THOMAS,
Resident Assistant Engineer.

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APPENDIX G G.

IMPROVEMENT OF MONONGAHELA AND ALLEGHENY RIVERS, WEST VIRGINIA AND PENNSYLVANIA.

REPORT OF MAJ. CHAS. F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monongahela River, West Virginia.
2. Operating and care of locks and dams, Nos. 1 to 9, Monongahela River.
3. Allegheny River, Pennsylvania.
4. Construction of locks and dams at Herr Island, above the head of Six-Mile Island, and at Springdale, Allegheny River.

SURVEY.

5. For removal of dam in the Upper Allegheny River near Corydon, Pa., and of dams and rapids in Conewango Creek.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., July 14, 1898.

GENERAL: I have the honor to transmit herewith annual reports of works under my charge for the year ending June 30, 1898.

CHAS. F. POWELL,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

G G 1.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA.

Several years ago the United States built Locks and Dams Nos. 8 and 9, the former being in Pennsylvania, and the latter in West Virginia, and which extended existing slack water upstream to next beyond

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Morgantown and made that place the head of packet and ordinary navigation.

The river and harbor act of 1896 provided for a further extension of slack water by the construction of six locks and dams between Morgantown and Fairmont, W. Va., 25 miles upstream, the principal object being to afford water transportation for coal from river mines near Fairmont.

At the beginning of the year a contract for the entire construction had been awarded to Mr. James McCarron, Philadelphia, who failed, after extensions of time had been granted, to furnish satisfactory bonds. All bids thereupon were rejected, and the contract let to Mr. C. I. McDonald, of Pittsburg, the lowest bidder at a second opening of bids, for completion of the constructions within four years from date of notice that the United States had acquired title to the necessary lands. The contract was approved December 9.

The contractor promptly commenced active operations at Lock No. 10, on April 12, by excavating for the lock pit. This work and cofferdam building were somewhat interrupted by spring freshets, but by the end of the year the cofferdam, inclosing the lock pit and space for guard cribs, had been completed, the excavation made, the cribs partly constructed, and considerable machinery and material delivered at the site.

It is expected that the masonry at No. 10 will be completed this season; also that active operations will be begun at Lock and Dam No. 11.

The locks and dams are to be built of concrete, the lifts to be 10⅔ feet, and the average height of lock walls above crests of dams 8 feet. The total lift, 64 feet, will back the water into the mouths of the forks, Tygarts Valley and West Fork, of the river above Fairmont. The controlling depth on lock sills at pool level is to be 7 feet, and the lock chambers large enough to take in two coal boats abreast or of the same width, 56 feet, as the large locks at the lower dams of the river.

Since last report the location of Lock and Dam No. 10 has been changed from below the Morgantown Bridge to a site 3,000 feet above the bridge. The lands for Locks and Dams 10, 11, and 12 were purchased, options on the remaining sites being held; topographical surveys made at all the sites, and about 700 borings made into the underlying rock at various proposed or selected sites to determine depth and character of foundations and fix exact locations of structures. The line of primary levels from Lock No. 9 to Hoults (upper site for Lock 15) was extended to the junction of the Tygarts Valley River and West Fork, and permanent bench marks placed along the extension.

Mr. J. C. Barr, draftsman, and J. A. McCulloch, assistant engineer, have been of much service in making topographical surveys and preparing detail and working drawings of the locks and dams.

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Money statement.

July 1, 1897, balance unexpended		$419,211.05
Amount appropriated by sundry civil act approved July 1, 1898		400,000.00
		819,211.05
June 30, 1898, amount expended during fiscal year		13,963.76
July 1, 1898, balance unexpended		805,247.29
July 1, 1898, outstanding liabilities	$4,663.48	
July 1, 1898, amount covered by uncompleted contracts	600,814.00	
		605,477.48
July 1, 1898, balance available		199,769.81
Amount (estimated) required for completion of existing project		350,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

June 10, 1872, improving Monongahela River between Morgantown and New Geneva	$25,000
March 3, 1873, improving Upper Monongahela River near Morgantown, W. Va.	66,000
June 23, 1874, improving Upper Monongahela River near Morgantown, W. Va.	25,000
March 3, 1875, improving Upper Monongahela River near Morgantown, W. Va.	22,000
June 18, 1878, improving Monongahela River, West Virginia and Pennsylvania	25,000
March 3, 1879, improving Monongahela River, West Virginia and Pennsylvania	24,000
June 14, 1880, improving Monongahela River, West Virginia	25,000
March 3, 1881, improving Monongahela River, Pennsylvania and West Virginia	25,000
August 2, 1882, improving Monongahela River, West Virginia	25,000
July 5, 1884, improving Monongahela River, West Virginia	45,000
August 5, 1886, improving Monongahela River, Pennsylvania and West Virginia	90,900
August 11, 1888, improving Monongahela River, West Virginia	35,000
September 25, 1889 (allotment)	4,000
July 13, 1892, improving Monongahela River, West Virginia	25,000
August 18, 1894, improving Monongahela River, West Virginia and Pennsylvania	20,000
June 3, 1896, improving Upper Monongahela River, West Virginia	30,000
June 4, 1897, improving Upper Monongahela River, West Virginia	350,000
July 1, 1898, improving Upper Monongahela River, West Virginia	400,000
Total	1,261,900

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., opened at 12 m., October 30, 1897, by Maj. Charles F. Powell, Corps of Engineers.

Materials.	Quantities.	1.—Joseph J. Churchyard, Buffalo, N. Y.a		2.—I. V. Hoag, jr., Pittsburg, Pa.		3.—Jutte & Foley Co., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
LOCKS AND DAMS NOS. 10 AND 11.							
Grubbing and clearing	.....	$50.00	$50.00	$1.00	$1.00	$500.00	$500.00
Excavation:							
Earth .....cubic yards..	36,549	.29	10,599.21	1.00	36,549.00	.60	21,929.40
Hardpan.....do....	100	.80	80.00	1.00	100.00	1.90	190.00
Rock .....do....	3,742	1.00	3,742.00	1.00	3,742.00	1.90	7,109.80
Embankment.....do....	4,734	.18	852.12	.35	1,656.90	.35	1,656.90
Concrete.....do....	35,955	5.65	203,145.75	8.00	287,640.00	8.00	287,640.00
Stone ballast in cribs....do....	1,572	1.00	1,572.00	1.50	2,358.00	1.60	2,515.20
Stone paving...square yards..	4,806	1.75	8,410.50	1.20	5,767.20	2.00	9,612.00
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	39.00	4,105.61	60.00	6,316.32	60.00	6,316.32
For cribs, Class A...do....	135,907	20.00	2,718.14	30.00	4,077.21	28.00	3,805.40
For cribs, Class B...do....	77,322	26.00	2,010.37	30.00	2,319.66	25.00	1,933.05
Bolts:							
Drift.....pounds..	13,833	.02½	311.24	.03	414.99	.03½	484.16
Screw .....do....	1,000	.03	30.00	.05	50.00	.04	40.00
Total.....	.....	.....	237,626.94	.....	350,992.28	.....	343,732.23
LOCKS AND DAMS NOS. 12 AND 13.							
Grubbing and clearing	.....	50.00	50.00	1.00	1.00	500.00	500.00
Excavation:							
Earth .....cubic yards..	4,900	.29	1,421.00	2.00	9,800.00	.80	3,920.00
Hardpan.....do....	4,048	.80	3,238.40	2.00	8,096.00	1.90	7,691.20
Rock.....do....	2,830	1.00	2,830.00	2.00	5,660.00	1.90	5,377.00
Embankment.....do....	9,827	.18	1,768.86	.35	3,439.45	.35	3,439.45
Concrete.....do....	31,278	5.65	176,720.70	8.00	250,224.00	8.00	250,224.00
Stone ballast in cribs....do....	1,829	1.00	1,829.00	1.60	2,926.40	1.60	2,926.40
Stone paving...square yards..	5,575	1.75	9,756.25	1.25	6,968.75	1.75	9,756.25
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	39.00	4,105.61	60.00	6,316.32	60.00	6,316.32
For cribs, Class A...do....	140,727	20.00	2,814.54	30.00	4,221.81	25.00	3,518.18
For cribs, Class B...do....	82,924	26.00	2,156.02	30.00	2,487.72	28.00	2,321.87
Bolts:							
Drift.....pounds..	15,442	.02½	347.45	.03	463.26	.03½	540.47
Screw..... .....do....	1,000	.03	30.00	.05	50.00	.04	40.00
Total.....	.....	.....	207,067.83	.....	300,654.71	.....	296,571.14
LOCKS AND DAMS NOS. 14 AND 15.							
Grubbing and clearing	.....	50.00	50.00	200.00	200.00	500.00	500.00
Excavation:							
Earth .....cubic yards..	11,861	.29	3,439.69	2.00	23,722.00	.60	7,116.60
Hardpan.....do....	1,316	.80	1,052.80	2.00	2,632.00	1.90	2,500.40
Rock.....do....	1,552	1.00	1,552.00	2.00	3,104.00	1.90	2,948.80
Embankment.....do....	9,730	.18	1,751.40	.40	3,892.00	.35	3,405.50
Concrete.....do....	30,552	5.65	172,505.80	8.00	244,256.00	8.00	244,256.00
Stone ballast in cribs ...do....	1,882	1.00	1,882.00	1.50	2,823.00	1.50	2,823.00
Stone paving...square yards..	6,000	1.75	10,500.00	1.20	7,200.00	1.60	9,600.00
Timber							
For gates, spars, quoins, and sills.....feet B. M..	105,272	39.00	4,105.61	60.00	6,316.32	60.00	6,316.32
For cribs, Class A...do....	142,797	20.00	2,855.94	30.00	4,283.91	24.00	3,427.13
For cribs, Class B...do....	82,924	26.00	2,156.02	30.00	2,487.72	26.00	2,156.02
Bolts:							
Drift.....pounds..	15,110	.02½	339.98	.03	453.30	.03½	528.85
Screw.....do....	1,000	.03	30.00	.04	40.00	.04	40.00
Total.....	.....	.....	202,221.24	.....	301,410.25	.....	285,618.62

a States over his signature that he bids as a whole, and does not bind himself to accept any particular lock and dam.

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., etc.—Continued.

Materials.	Quantities.	4.—J. W. Hoffman & Co., Philadelphia, Pa.[a]		5.—McArthur Bros. Co., Chicago, Ill.		6.—Isaac T. Brown, New York, N. Y.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
LOCKS AND DAMS NOS. 10 AND 11.							
Grubbing and clearing		$100.00	$100.00	$3,000.00	$3,000.00	$200.00	$200.00
Excavation:							
Earth.....cubic yards..	36,549	.50	18,274.50	1.60	58,478.40	1.00	36,549.00
Hardpan.....do....	100	.50	50.00	2.20	220.00	1.00	100.00
Rock.....do....	2,742	2.00	7,484.00	4.00	14,968.00	1.00	3,742.00
Embankment.....do....	4,734	.40	1,893.60	1.00	4,734.00	.30	1,420.20
Concrete.....do....	35,955	6.00	215,730.00	5.50	197,752.50	7.00	251,685.00
Stone ballast in cribs....do....	1,572	1.50	2,358.00	2.25	3,537.00	1.40	2,200.80
Stone paving...square yards..	4,806	1.50	7,209.00	2.50	12,015.00	1.75	8,410.50
Timber:							
For gates, spars, quoins, and sills.....feet B. M...	105,272	53.00	5,579.42	60.00	6,316.32	50.00	5,263.60
For cribs, Class A...do....	135,907	33.00	4,484.93	25.00	3,397.68	50.00	6,795.35
For cribs, Class B...do....	77,322	34.00	2,628.95	28.00	2,165.02	30.00	2,319.66
Bolts:							
Drift.....pounds..	13,833	.03	414.99	.03	414.99	.02½	345.83
Screw.....do....	1,000	.03	30.00	.04	40.00	.04	40.00
Total.....	.....	.....	266,237.39	.....	307,038.91	.....	319,071.94
LOCKS AND DAMS NOS. 12 AND 13.							
Grubbing and clearing.....	.....	100.00	100.00	3,000.00	3,000.00	200.00	200.00
Excavation:							
Earth.....cubic yards..	4,900	.50	2,450.00	1.60	7,840.00	1.00	4,900.00
Hardpan.....do....	4,048	.50	2,024.00	2.60	10,524.80	1.00	4,048.00
Rock.....do....	2,830	2.00	5,660.00	5.00	14,150.00	1.00	2,830.00
Embankment.....do....	9,827	.40	3,930.80	1.00	9,827.00	.30	2,948.10
Concrete.....do....	31,278	5.85	182,976.30	6.00	187,668.00	7.00	218,946.00
Stone ballast in cribs....do....	1,829	1.50	2,743.50	2.40	4,389.60	1.40	2,560.60
Stone paving...square yards..	5,575	1.50	8,362.50	2.50	13,937.50	1.75	9,756.25
Timber:							
For gates, spars, quoins, and sills.....feet B. M...	105,272	53.00	5,579.42	60.00	6,316.32	50.00	5,263.60
For cribs, Class A...do....	140,727	33.00	4,643.99	25.00	3,518.18	50.00	7,036.35
For cribs, Class B...do....	82,924	34.00	2,819.42	28.00	2,321.87	30.00	2,487.72
Bolts:							
Drift.....pounds..	15,442	.03	463.26	.03	463.26	.02½	386.05
Screw.....do....	1,000	.03	30.00	.04	40.00	.04	40.00
Total.....	.....	.....	221,783.19	.....	263,996.53	.....	261,402.67
LOCKS AND DAMS NOS. 14 AND 15.							
Grubbing and clearing.....	.....	100.00	100.00	3,000.00	3,000.00	200.00	200.00
Excavation:							
Earth.....cubic yards..	11,861	.50	5,930.50	1.60	18,977.60	1.00	11,861.00
Hardpan.....do....	1,316	.50	658.00	2.60	3,421.60	1.00	1,316.00
Rock.....do....	1,552	2.00	3,104.00	5.50	8,536.00	1.00	1,552.00
Embankment.....do....	9,730	.40	3,892.00	1.00	9,730.00	.30	2,919.00
Concrete.....do....	30,532	6.00	183,192.00	5.50	167,926.00	7.00	213,724.00
Stone ballast in cribs....do....	1,882	1.50	2,823.00	2.25	4,234.50	1.40	2,634.80
Stone paving...square yards..	6,000	1.50	9,000.00	2.50	15,000.00	1.75	10,500.00
Timber:							
For gates, spars, quoins, and sills.....feet B. M...	105,272	53.00	5,579.42	60.00	6,316.32	50.00	5,263.60
For cribs, Class A...do....	142,797	33.00	4,712.30	25.00	3,569.93	50.00	7,139.85
For cribs, Class B...do....	82,924	34.00	2,819.42	28.00	2,321.87	30.00	2,487.72
Bolts:							
Drift.....pounds..	15,110	.03	453.30	.03	453.30	.02½	377.75
Screw.....do....	1,000	.03	30.00	.04	40.00	.04	40.00
Total.....	.....	.....	222,293.94	.....	243,527.12	.....	260,015.72

[a] Offers to make price on concrete $5.70 per cubic yard if awarded all six dams.

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., etc.—Continued.

Materials.	Quantities.	7.—John J. Shipman, Washington, D. C.		8.—The Houston Construction Co., Philadelphia, Pa.		9.—Heldmaier & Neu, Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
LOCKS AND DAMS NOS. 10 AND 11.							
Grubbing and clearing	.....	.....	.....	$200.00	$200.00	$200.00	$200.00
Excavation:							
Earth.....cubic yards..	36,549	.....	.....	.40	14,619.60	.42	15,350.58
Hardpan.....do....	100	.....	.....	.90	90.00	1.20	120.00
Rock .....do....	3,742	.....	.....	2.25	8,419.50	1.20	4,490.40
Embankment.....do....	4,734	.....	.....	.35	1,656.90	.30	1,420.20
Concrete.....do....	35,955	.....	.....	6.00	215,730.00	5.85	210,336.75
Stone ballast in cribs ...do....	1,572	.....	.....	1.50	2,358.00	1.25	1,965.00
Stone paving...square yards..	4,806	.....	.....	1.85	8,891.10	2.30	11,053.80
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	.....	.....	75.00	7,895.40	60.00	6,316.32
For cribs, Class A...do....	135,907	.....	.....	30.00	4,077.21	32.00	4,434.93
For cribs, Class B...do....	77,322	.....	.....	37.00	2,860.91	35.00	2,706.27
Bolts:							
Drift.....pounds..	13,833	.....	.....	.05	691.65	.03	414.99
Screw.....do....	1,000	.....	.....	.05	50.00	.03	30.00
Total.....	.....	.....	.....	.....	267,540.27	.....	258,889.24
LOCKS AND DAMS NOS. 12 AND 13.							
Grubbing and clearing	.....	.....	.....	200.00	200.00	300.00	300.00
Excavation:							
Earth.....cubic yards..	4,900	.....	.....	.38	1,862.00	.45	2,205.00
Hardpan.....do....	4,048	.....	.....	.90	3,643.20	1.10	4,452.80
Rock .....do....	2,830	.....	.....	1.60	4,528.00	1.20	3,396.00
Embankment.....do....	9,827	.....	.....	.33	3,242.91	.35	3,439.45
Concrete.....do....	31,278	.....	.....	5.87	183,601.86	6.15	192,359.70
Stone ballast in cribs ...do....	1,829	.....	.....	1.27	2,322.83	1.32	2,414.28
Stone paving...square yards..	5,575	.....	.....	2.10	11,707.50	2.30	12,823.50
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	.....	.....	75.00	7,895.40	63.00	6,632.14
For cribs, Class A...do....	140,727	.....	.....	34.00	4,784.72	35.00	4,925.45
For cribs, Class B...do....	82,924	.....	.....	34.50	2,860.88	36.50	3,026.73
Bolts:							
Drift.....pounds..	15,442	.....	.....	.05	772.10	.03	463.26
Screw.....do....	1,000	.....	.....	.05	50.00	.03	30.00
Total.....	.....	.....	.....	.....	227,471.40	.....	236,467.31
LOCKS AND DAMS NOS. 14 AND 15.							
Grubbing and clearing	.....	$6,000.00	$6,000.00	200.00	200.00	200.00	200.00
Excavation:							
Earth.....cubic yards..	11,861	3.50	41,513.50	.38	4,507.18	.42	4,981.62
Hardpan.....do....	1,316	3.50	4,606.00	.90	1,184.40	1.10	1,447.60
Rock .....do....	1,552	3.50	5,432.00	1.70	2,638.40	1.30	2,017.60
Embankment.....do....	9,730	.20	1,946.00	.35	3,405.50	.37	3,600.10
Concrete.....do....	30,532	8.00	244,256.00	6.00	183,192.00	5.85	178,612.20
Stone ballast in cribs ...do....	1,882	1.50	2,823.00	1.25	2,352.50	1.20	2,258.40
Stone paving...square yards..	6,000	1.25	7,500.00	1.85	11,100.00	2.30	13,800.00
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	100.00	10,527.20	70.00	7,369.04	63.00	6,632.14
For cribs, Class A...do....	142,797	40.00	5,711.88	32.00	4,712.30	35.00	4,997.90
For cribs, Class B...do....	82,924	40.00	3,316.96	37.00	3,068.19	36.50	3,026.73
Bolts:							
Drift.....pounds..	15,110	.03	453.30	.05	755.50	.03	453.30
Screw.....do....	1,000	.03	30.00	.05	50.00	.03	30.00
Total.....	.....	.....	334,115.84	.....	224,535.01	.....	222,057.59

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., etc.—Continued.

Materials.	Quantities.	10.—The T. A. Gillespie Co., Pittsburg, Pa.		11.—Jacob Friday & Sons, Pittsburg, Pa.		12.—Sweeney, Houston & Bowman Bros., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
LOCKS AND DAMS NOS. 10 AND 11.							
Grubbing and clearing	.....	$200.00	$200.00	$400.00	$400.00	.....	.....
Excavation:							
Earth..... cubic yards..	36,549	.25	9,137.25	.50	18,274.50	.....	.....
Hardpan.....do....	100	.70	70.00	1.00	100.00	.....	.....
Rock.....do....	3,742	1.25	4,677.50	3.00	11,226.00	.....	.....
Embankment.....do....	4,734	.25	1,183.50	.35	1,656.90	.....	.....
Concrete.....do....	35,955	5.75	206,741.25	5.75	206,741.25	.....	.....
Stone ballast in cribs ...do....	1,572	1.50	2,358.00	1.35	2,122.20	.....	.....
Stone paving...square yards..	4,806	1.75	8,410.50	1.50	7,209.00	.....	.....
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	50.00	5,263.60	50.00	5,263.60	.....	.....
For cribs, Class A...do....	135,907	29.50	4,009.26	25.00	3,397.68	.....	.....
For cribs, Class B...do....	77,322	34.50	2,667.61	35.00	2,706.27	.....	.....
Bolts:							
Drift.....pounds..	13,833	.02	276.66	.03	414.99	.....	.....
Screw.....do....	1,000	.02½	25.00	.04	40.00	.....	.....
Total.....	.....	.....	245,020.13	.....	259,552.39	.....	.....
LOCKS AND DAMS NOS. 12 AND 13.							
Grubbing and clearing.....	.....	200.00	200.00	400.00	400.00	$3,000.00	$3,000.00
Excavation:							
Earth..... cubic yards..	4,900	.40	1,960.00	.50	2,450.00	.38	1,862.00
Hardpan.....do....	4,048	.70	2,833.60	1.00	4,048.00	1.63	6,598.24
Rock .....do....	2,830	1.25	3,537.50	3.00	8,490.00	2.00	5,660.00
Embankment.....do....	9,827	.25	2,456.75	.35	3,439.45	.38	3,734.26
Concrete.....do....	31,278	5.75	179,848.50	5.95	186,104.10	6.31	197,364.18
Stone ballast in cribs ...do....	1,829	1.50	2,743.50	1.35	2,469.15	2.25	4,115.25
Stone paving...square yards..	5,575	1.75	9,756.25	1.50	8,362.50	1.89	10,536.75
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	50.00	5,263.60	50.00	5,263.60	55.00	5,789.96
For cribs, Class A...do....	140,727	29.50	4,151.45	25.00	3,518.18	35.00	4,925.45
For cribs, Class B...do....	82,924	34.50	2,860.88	35.00	2,902.34	40.00	3,316.96
Bolts:							
Drift.....pounds..	15,442	.02	308.84	.03	463.26	.05	772.10
Screw.....do....	1,000	.02½	25.00	.04	40.00	.07	70.00
Total.....	.....	.....	215,945.87	.....	227,950.58	.....	247,745.15
LOCKS AND DAMS NOS. 14 AND 15.							
Grubbing and clearing.....	.....	200.00	200.00	400.00	400.00	3,000.00	3,000.00
Excavation:							
Earth.....cubic yards..	11,861	.40	4,744.40	.50	5,930.50	.40	4,744.40
Hardpan.....do....	1,316	.70	921.20	1.00	1,316.00	1.63	2,145.08
Rock.....do....	1,552	1.25	1,940.00	3.00	4,656.00	2.00	3,104.00
Embankment.....do....	9,730	.25	2,432.50	.35	3,405.50	.40	3,892.00
Concrete.....do....	30,532	5.75	175,559.00	5.95	181,665.40	6.46	197,236.72
Stone ballast in cribs ...do....	1,882	1.50	2,823.00	1.35	2,540.70	2.25	4,234.50
Stone paving...square yards..	6,000	1.75	10,500.00	1.50	9,000.00	1.89	11,340.00
Timber:							
For gates, spars, quoins, and sills.....feet B. M..	105,272	50.00	5,263.60	50.00	5,263.60	55.00	5,789.96
For cribs, Class A...do....	142,797	29.50	4,212.51	25.00	3,569.93	35.00	4,997.90
For cribs, Class B...do....	82,924	34.50	2,860.88	35.00	2,902.34	40.00	3,316.96
Bolts:							
Drift.....pounds..	15,110	.02	302.20	.03	453.30	.05	755.50
Screw.....do....	1,000	.02½	25.00	.04	40.00	.07	70.00
Total.....	.....	.....	211,784.29	.....	221,143.27	.....	244,627.02

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., etc.—Continued.

Materials.	Quantities.	13.—Wm. E. Hingston & F. M. Sylvester. Buffalo. N. Y.		14.—C. I. McDonald, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.
LOCKS AND DAMS NOS. 10 AND 11.					
Grubbing and clearing	.....	$100.00	$100.00	$100.00	$100.00
Excavation:					
Earth.....cubic yards..	36,549	.45	16,447.05	.33⅓	12,183.00
Hardpan.....do....	100	1.40	140.00	.60	60.00
Rock.....do....	3,742	2.00	7,484.00	.80	2,993.60
Embankment.....do....	4,734	.30	1,420.20	.35	1,656.90
Concrete.....do....	35,955	5.70	204,943.50	5.00	179,775.00
Stone ballast in cribs.....do....	1,572	1.50	2,358.00	1.09	1,713.48
Stone paving.....square yards..	4,806	1.50	7,209.00	.75	3,604.50
Timber:					
For gates, spars, quoins, and sills, feet B. M.....	105,272	65.00	6,842.68	50.00	5,263.60
For cribs, class A.....feet B. M..	135,907	30.00	4,077.21	18.00	2,446.33
For cribs, Class B.....do....	77,322	35.00	2,706.27	23.00	1,778.41
Bolts:					
Drift.....pounds..	13,833	.03½	484.16	.02½	380.41
Screw.....do....	1,000	.04	40.00	.03½	35.00
Total.....	.....	.....	254,252.07	.....	211,990.23
LOCKS AND DAMS NOS. 12 AND 13.					
Grubbing and clearing	.....	200.00	200.00	100.00	100.00
Excavation:					
Earth.....cubic yards..	4,900	.50	2,450.00	.45	2,205.00
Hardpan.....do....	4,048	1.20	4,857.60	.60	2,428.80
Rock.....do....	2,830	2.00	5,660.00	1.00	2,830.00
Embankment.....do....	9,827	.35	3,439.45	.35	3,439.45
Concrete.....do....	31,278	5.70	178,284.60	5.25	164,209.50
Stone ballast in cribs.....do....	1,829	2.00	3,658.00	1.09	1,993.61
Stone paving.....square yards..	5,575	2.00	11,150.00	.75	4,181.25
Timber:					
For gates, spars, quoins, and sills, feet B. M.....	105,272	65.00	6,842.68	50.00	5,263.60
For cribs, Class A.....feet B. M..	140,727	30.00	4,221.81	18.00	2,533.09
For cribs, Class B.....do....	82,924	35.00	2,902.34	23.00	1,907.25
Bolts:					
Drift.....pounds..	15,442	.03½	540.47	.02½	424.66
Screw.....do....	1,000	.04	40.00	.03½	35.00
Total.....	.....	.....	224,246.95	.....	191,551.21
LOCKS AND DAMS NOS. 14 AND 15.					
Grubbing and clearing	.....	200.00	200.00	100.00	100.00
Excavation:					
Earth.....cubic yards..	11,861	.45	5,337.45	.55	6,523.55
Hardpan.....do....	1,316	1.20	1,579.20	.60	789.60
Rock.....do....	1,552	2.00	3,104.00	1.15	1,784.80
Embankment.....do....	9,730	.35	3,405.50	.35	3,405.50
Concrete.....do....	30,532	5.70	174,032.40	5.50	167,926.00
Stone ballast in cribs.....do....	1,882	2.00	3,764.00	1.09	2,051.38
Stone paving.....square yards..	6,000	2.00	12,000.00	.75	4,500.00
Timber:					
For gates, spars, quoins, and sills, feet B. M.....	105,272	65.00	6,842.68	50.00	5,263.60
For cribs, Class A.....feet B. M..	142,797	30.00	4,283.91	18.00	2,570.35
For cribs, Class B.....do....	82,924	35.00	2,902.34	23.00	1,907.25
Bolts:					
Drift.....pounds..	15,110	.03½	528.85	.02½	415.53
Screw.....do....	1,000	.04	40.00	.03½	35.00
Total.....	.....	.....	218,020.33	.....	197,272.56

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River at and above Morgantown, W. Va., etc.—Continued.

SUMMARY OF ITEMIZED ABSTRACT.

No.	Name and address.	Lock and dams Nos.—		
		10 and 11.	12 and 13.	14 and 15.
1	Joseph J. Churchyard, Buffalo, N. Y. *a*	$237, 626. 94	$207, 067. 83	$202, 221. 24
2	L. V. Hoag, jr., Pittsburg, Pa	350, 992. 28	300, 654. 71	301, 410. 25
3	Jutte & Foley Co., Pittsburg, Pa	343, 732. 23	296, 571. 14	285, 618. 62
4	J. W. Hoffman & Co., Philadelphia, Pa. *b*	266, 237. 39	221, 783. 19	222, 293. 94
5	McArthur Brothers Co., Chicago, Ill	307, 038. 91	263, 996. 53	243, 527. 12
6	Isaac T. Brown, New York, N. Y	319, 071. 94	261, 402. 67	260, 015. 72
7	John J. Shipman, Washington, D. C	.....	.....	334, 115. 84
8	The Houston Construction Co., Philadelphia, Pa	267, 540. 27	227, 471. 40	224, 535. 01
9	Heldmaier & Neu, Chicago, Ill	258, 889. 24	236, 467. 31	222, 057. 59
10	The T. A. Gillespie Co., Pittsburg, Pa	245, 020. 13	215, 945. 87	211, 784. 29
11	Jacob Friday & Sons, Pittsburg, Pa	259, 552. 39	227, 950. 58	221, 143. 27
12	Sweeney, Houston & Bowman Bros., Pittsburg, Pa	.....	247, 745. 15	244, 627. 02
13	William E. Hingston and F. M. Sylvester, Buffalo, N. Y	254, 252. 07	224, 246. 95	218, 020. 33
14	C. I. McDonald, Pittsburg, Pa	211, 990. 23	191, 551. 21	197, 272. 56

a States over his signature that he bids as a whole and does not bind himself to accept any particular lock and dam.

b Offers to make price on concrete $5.70 per cubic yard if awarded all six dams.

Contract in force during fiscal year ending June 30, 1898.

No.	Name of contractor.	For—	Date of—		
			Approval.	Beginning work.	Expiration.
1	C. I. McDonald, Pittsburg, Pa.	Locks and dams Nos. 10-15, on Monongahela River.	Dec. 9, 1897	Apr. 12, 1898	Four years from acquirement of necessary lands.

COMMERCIAL STATISTICS.

Two daily lines of packets run from Pittsburg to Morgantown. A towboat and a steam tug work for a sawmill in Pool 8, or do jobbing, generally in Pools 8 and 9.

Comparative statement of commerce that passed through United States Locks Nos. 8 and 9 for the past six years.

Year.	Lock No. 8.		Lock No. 9.	
	Passengers.	Freight.	Passengers.	Freight.
	Number.	*Tons.*	*Number.*	*Tons.*
1892 (calendar year)	18, 663	20, 769. 69	17, 932	20, 644. 45
1893 (calendar year)	24, 534	17, 587. 11	23, 932	19. 426. 83
1894 (calendar year)	18, 610	24, 328. 55	16, 968	17, 134. 10
1895 (calendar year)	15, 107	19, 825. 99	11, 459	10, 758. 62
1896 (calendar year)	11, 006	31, 722. 22	11, 296	13, 734. 95
1898 (fiscal year)	29, 124	64, 138. 00	26, 428	33, 543. 00

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Bench marks, leveling of 1897, by I. N. Lucas, under supervision of Assistant Engineer Philip Golay, Hoult's mill to near head of river.

[Assumed datum is mean tidal level at Sandy Hook, N. J., obtained by means of railroad levels connected with principal bench of Pennsylvania Railroad at Uniontown, Pa.]

Elevation.	Bench.
859.589	Railroad spike in sycamore, right bank, near below Hoult's mill.
873.507	Railroad spike in chestnut, right bank, near above Aurora Mine.
885.474	Northeast corner, center pier, railroad bridge across river below Fairmont. B. M., cut. Bottom of bridge same elevation.
899.681	West corner, bridge seat, northwest abutment, Fairmont Suspension Bridge.
844.810	Zero of river gage, Fairmont, W. Va.
886.593	Extreme southwest or upper corner, bridge seat, north abutment, Baltimore and Ohio R. R. bridge above Fairmont. B. M., cut. Bottom of bridge same elevation.
882.516	East corner, north abutment, New England R. R. bridge. B. M., cut.
880.083	Bottom of New England R. R. bridge.
887.728	Highest point on lower wall of abutment, Honsacker Bridge, left side of river. B. M., cut.
884.479	Bottom of Honsacker Bridge.
868.719	Railroad spike in walnut below railroad, left bank, upper end of coke ovens, Watson Mines.
885.630	Railroad spike in sycamore, above railroad, Gaston Station.
887.673	Southeast corner, center pier, Monongahela River railroad bridge. B. M., cut. Bottom of bridge same elevation.
884.746	Railroad spike in chestnut about one-fourth mile above Thompson, right bank, below railroad.
885.350	Point on upper wall, railroad culvert, lower end of railroad curve and cut near below White Rock. B. M., cut.
859.686	Railroad spike in sycamore, head of ripple below Monongah, right shore.
884.680	South corner, northeast pier, railroad bridge, Booths Creek, Monongah. B. M., cut.

G G 2.

OPERATING AND CARE OF LOCKS AND DAMS ON MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

Under authority of the river and harbor act of 1896 the United States acquired, near the beginning of the year, the property and appurtenances of the Monongahela Navigation Company. The property includes seven dams and sets of locks, which make slack water from near the mouth of the river at Pittsburg to Lock No. 8. Locks Nos. 1, 2, 3, and 4 are double locks, each set consisting of one large lock and one small lock; Locks Nos. 5, 6, and 7 are single and small locks. A history of the purchased slack-water system and an estimate of cost of its enlargement and improvement for affording adequate accommodation to a large and growing traffic are given in the last annual report, and may be found on pages 2412–2424 of the Report of the Chief of Engineers for that year. The traffic of the river is restricted and hampered by insufficient capacity at the locks and in the channels.

Effort was made during the year to lay down and define an extension of harbor lines upstream from their present end at the railroad bridge at Homestead to McKeesport, the mouth of the Youghiogheny, a river distance of about 7 miles. This has proved a laborious task from numerous conflicting interests and the condition that the work should be done without expense to the United States.

The abolition of lock tolls has been followed by a marked increase of traffic, especially in packet and excursion business and transportation of coal for local consumption.

Locks 8 and 9 were operated from the first of the year, and Locks 1, 2, 3, 4, 5, 6, and 7, from July 7, on which date the properties of the Monongahela Navigation Company were transferred to the United States.

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The number of monthly lockages of vessels was as follows:

1897.	Dam.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
July	1,683	1,497	834	680	367	140	155	202	152
August	1,430	1,090	504	411	440	218	209	269	197
September	1,426	1,252	708	783	401	222	193	272	182
October	1,459	1,500	955	1,038	334	186	197	330	181
November	1,687	1,842	1,275	1,364	277	145	142	180	164
December	2,711	2,543	1,565	1,650	273	156	123	159	123
1898.									
January	1,791	1,842	1,227	1,165	195	133	92	101	97
February	1,569	1,593	1,164	1,060	236	83	63	77	53
March	1,815	1,868	1,310	1,261	298	132	97	113	94
April	2,099	1,998	1,246	1,237	334	178	147	187	141
May	2,244	2,154	1,365	1,240	342	164	143	182	160
June	1,692	1,823	1,302	1,284	371	194	167	274	212
Total	21,606	21,002	13,455	13,173	3,868	1,951	1,728	2,346	1,756

The locks were temporarily closed to navigation and for reasons as follows:

Locks.	Repairs or leakage.			Accidents.			Floods.			Ice.			Total time.			No. of times.
	d.	h.	m.	d.	h.	m.	d.	h.	m.	d.	h.	m.	d.	h.	m.	
No. 1 Large	1	11	40				5	7	0				6	18	40	6
No. 1 Small		10	0				5	7	0				5	17	0	5
No. 2 Large					7	0	4	20	20				5	3	20	4
No. 2 Small							4	20	20				4	20	20	3
No. 3 Large		12	0				2	22	0	3	0	0	6	10	0	7
No. 3 Small	a44	0	0				2	22	0				46	22	0	3
No. 4 Large					4	12	1	5	30	5	0	0	6	9	42	5
No. 4 Small	a41	0	0				11	6	0	5	0	0	57	6	0	7
No. 5		21	0				2	8	20	9	0	0	12	5	20	5
No. 6							2	14	0	9	0	0	11	14	0	4
No. 7		18	0				7	10	0	9	9	0	17	13	0	10
No. 8							1	4	5	8	0	0	9	4	5	4
No. 9							9	8	0	9	0	0	18	8	0	9

a Low water.

The following were the principal repairs made to the structures and works done for maintenance of channel:

Lock and Dam No. 1, Pittsburg.—Two boilers used for generating power to operate lock gates and 389 feet of exposed steam pipe were covered with dolomite sectional covering. A tight board fence 285 feet in length was constructed around the lock land. A shelter house for lock hands was built on the river wall, taking the place of a similar structure destroyed by a flood in 1896. A coal bin with wagon-door entrance at Second avenue was provided in rear of boiler house. Repairs were made to engine-room floor on land wall and to lockmaster's dwelling, the latter comprising a number of new window sashes, painting, plastering, and plumbing work. New chain spools connected with machinery of lower large gate on land wall was put in place. New cast-iron hood on the heel post of one of the gates of the small lock to which the suspension bars are attached was put in place of a broken one. New anchorage iron for one of the upper gates of the large lock was substituted for a damaged one. Several sections of 3¼-inch defective shafting on middle wall were replaced with 4-inch shafting. One section of 3¼-inch shafting on land wall and expansion coupling were taken out and replaced with new shaft and coupling.

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In August, in order to pass the new and large Ohio River towboat *Harry Brown* through the large lock, the steamer being too long for the chamber within gates, a tight bulkhead was placed at the head wall of the lock and the boat locked. The whole time, including the building and removal of the bulkhead, was eleven hours and forty minutes. The towboat was built above the dam, where all the boat yards of this vicinity are located.

A considerable amount of dredging work was necessary both above and below the locks to maintain the channel depths in the approaches. The extent of this work is given under the head of dredging.

Throughout the summer and fall flashboards were maintained on the dam, adding fully 2 feet to the available depth of Pool No. 1 and in Lock 2, which throughout the season, excepting for brief periods, was kept at 8 feet or over.

Lock and Dam No. 2, Port Perry.—About one-third of the crib outside of the river wall of the small lock was taken down and rebuilt from the water line to level of lock wall a height of 18 feet. A shelter house for lockmen was constructed on the middle wall between the two locks. The old and much-decayed crib, extending down the river 65 feet from the middle wall and which leaned over so as to threaten to fall and endanger navigation, was removed, that portion of it below the water line requiring the use of a dredge boat. In November work was commenced in repairing and raising 560 feet of the lower slope of the dam, requiring resheeting and much ballast stone, but after about 50 feet had been completed operations were suspended on account of high water. Extensive repairs were made to the engine house on the middle wall, and the coal bin attached covered with a new roof of corrugated iron. Three of the eight lock gates were thrown and their valves repaired. New beveled gearing was placed on the bottom of the shaft operated by the undershot wheel on the crest of the dam which supplies power for operating the river-wall gates of the small lock. New gate-suspension blocks of oak were placed on the walls for lower gates, one for each lock. The upper gates of both locks were repaired with new 3-inch oak protection sheeting, and other repairs to these gates made, due to accidental damages by vessels. The crib ice breakers, several hundred yards above the lock, from decay and neglect, no longer serving the purpose of deflecting ice and drift from the lock, several lines of piles were driven on a distance of 171 feet from the bank and well braced together, making a substantial deflecting dike. The flood current sets very hard toward the locks at this place, and on several occasions the office building on the middle wall has been carried away by floating vessels and wreckage. Flashboards were put on this dam the same as at No. 1, and a coal-boating stage maintained in the second pool throughout most of the period of the dry weather of the summer and fall. The Youghiogheny River enters the second pool 3 miles above Dam No. 2, and it is seldom that a surplus of water is not found flowing over Dams Nos. 1 and 2.

During May and June the approach to the locks from below was confined, by the opening in the false work of the Union Railroad Bridge in progress of construction, to a width of 75 feet, greatly inconveniencing the movement of coal fleets.

Lock and Dam No. 3, above Elizabeth.—Extensive repairs were made on 390 linear feet of main line and countershafting, power capstans, friction machinery, and turbine on the land wall of the large lock, requiring several weeks' constant work of the repair crew. One gate at the lower end of the large lock was thrown and leakages much reduced by

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inserting new bearings in the wicket boxes. One of the lower gates of the small lock was treated in the same manner. The position of a power capstan at the head of the middle wall was changed several feet and its gearing overhauled. The lockmaster's house was thoroughly repaired inside, several walls replastered, and new window sashes furnished. During the winter an ice gorge formed across the river about opposite the lower end of the small lock, and currents from beneath the ice washed a great deal of light gravel and ashes into the channel below the lock, for a time rendering the small lock useless for navigation and necessitating considerable dredging. Later in the season a freshet caused the deposit of so much material in the same place as to require a second removal of material. It is contemplated at an early date to slightly raise the dam at the abutment end and thus remove the cause of the eddy which forms the deposit complained of. During the dry weather of the fall the water declined in the third pool for a brief period to 13 inches below the crest of the permanent dam, or 3 feet below the top edge of the flashboards, which had been placed on the dam early in the summer, so that for a while the navigable depth in the channel, several miles above the dam, was not quite 5 feet.

Lock and Dam No. 4, below Charleroi.—Two hundred and eighty-two cubic yards of stone ballast was placed in the body of the dam along the lower slope. The top portion of the ice-breaker crib, extending 210 feet up the river from the outside lock wall, was repaired. A long section of the fender crib, extending along the shore above the lock, having slipped on its foundation so as to become a source of danger to vessels entering the lock (three vessels having sunk after striking it), was ordered to be rebuilt as early as possible this season, and operations were pushed actively in its reconstruction throughout May and June. The length of the new portion of the crib, including a gap in the old work now being closed, is 470 feet. Springs in the bank caused much material to slough off during the progress of the work, threatening at one time to disturb the safety of several buildings on the bank, but at the close of June the entire distance of 470 feet had been well secured. The crib stands in 12 feet of water and at present is 3 feet out of water, and when completed will have a height from base to top of 20 feet. There has been so far used in the work 191,250 feet B. M. oak timber, 8,575 pounds bolts, 2,332 cubic yards of ballast stone, and several hundred yards of river gravel. Upon the completion of the crib to the desired elevation, a considerable quantity of back filling will be required to make good the losses due to the sloughing of the bank during the progress of the work.

Lock and Dam No. 5, above Brownsville.—The cast-iron hood supporting the suspension bars of one of the gates broke in December. The gate was temporarily supported with chains until a new hood could be procured, and while being put in place involved the closing of the lock for twenty-one hours. Other repairs to the lock and its appurtenances were of a minor nature. Flashboards were maintained on the dam as on all the dams below, but with every effort made to economize in the use of water, and especially at Locks 3 and 4, closing the small locks to traffic and stopping leaks with straw and ashes, the pools continued to decline, so that on October 27 there was only 4 feet on the lower sill at Lock No. 5, reaching a minimum of 3.4 feet early in November; between October 27 and November 9, at which last-mentioned date the drought ceased, only light-draft, stern-wheel boats were able to pass Lock No. 5. The old locks and dams permit, it is believed, a greater volume of leakage than of water used in locking.

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Lock and Dam No. 6, Rice's Landing.—One of the repair crews was engaged continuously from the latter part of August to October 18 in raising the lower slope of the dam and effecting other necessary repairs and renewals to the structure. On a length of about 450 feet of the dam there were used 83,800 feet B. M. oak timber and plank and 794 cubic yards of ballast stone. A slight crown was given the central portion of the dam, with the object of destroying an eddy which at some stages of the river makes it difficult for descending rafts to clear the lock outlet.

Lock and Dam No. 7, below Greensboro.—The filling wickets were overhauled and reset and the dam was repaired and reballasted. A crib apron, 54 feet long, 16 feet wide, and about 10 feet deep, was constructed below the dam and next to the abutment.

The lock force fitted up an outbuilding for temporary dwelling for lock tender, constructed plank steps leading from a private roadway to the upper end of the land wall, and a plank walk from the upper end of these steps to the dwellings; also a plank walk on top of the guide crib above the river wall for the entire length of the crib.

In January, a landslide, consisting of 250 cubic yards of earth, was removed from against the upper side of the lock tender's temporary dwelling. In March excavation was commenced with a view of grading and improving the Government grounds back of the lock buildings. Earth was excavated back of the shop and as far upstream as the lock master's dwelling to the amount of 350 cubic yards, and was dumped over the bank below the lower end of the Government land. Because of much wet weather and the unsettled condition of the banks, this work was suspended until a more favorable season of the year.

Lock and Dam No. 8, mouth of Dunkards Creek.—A freshet in July, 1896, carried away a portion of the guide crib at the lower end of the land wall and washed out the filling below the lower wing wall of the lock. That portion of the guide crib above normal level of Pool No. 7 has been rebuilt, and a crib apron 16 feet wide was constructed for a protection below the lower wing wall. Both guide crib and apron were sheeted with plank. The abutment was taken down to the natural slope of the bank and the top course of stone was removed from the retaining wall on the abutment side of the river. The removed stones were used for heavy paving of the bank on each side of the T of the abutment. About 500 cubic yards of material taken from the bar below the dam was used filling washouts in the bank above and below the abutment, after which the bank was further protected with riprap for a distance of about 50 yards upstream from the abutment and about two-thirds of the distance up the bank slope. About twenty pieces of sheeting on the apron of the dam were found to be loose on account of the holes being too large for the boltheads. These have been securely spiked down. New closing chains for lower gates were procured and put in place.

At both dwellings new conductors were put up from the eave troughs to the cisterns, and new flooring and ceiling were put in the summer kitchen at the lock master's dwelling.

Lock and Dam No. 9, Hoard, W. Va.—A leak around the abutment was closed. The Stoney (discharge) valve has become troublesome to operate. The masonry about the discharge culvert is constructed of soft stone, which has crumbled away and will not hold the bolts securing the guides and bed plates, and the valve itself is much rusted and eaten away. Temporary repairs were made to the valve and drawings of an improved design made for a new valve.

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Boat yard and shop, Lock No. 4.—During the winter and early spring the repair crew framed and put together three new lock gates and partly made four other new gates. The average useful life of a lock gate on the Monongahela is about thirteen years, so that of the 52 lock gates connected with the 13 locks on the river about four must be replaced annually. Several service boats and skiffs for use about the locks were constructed and numerous repairs made to the lock-gate machinery, though most of the miscellaneous repair work was done on the crane boats at the particular locks requiring attention. Included in this work of the repair crews was the placing of flashboards on the dams, the removal of snags, and some of the wrecks of sunken vessels noted below.

Dredging done.—Below Lock No. 1, opposite Smithfield street, 2,700 cubic yards, and opposite Try street, Pittsburg Harbor, 1,100 cubic yards; between the Tenth Street Bridge and Lock No. 1, 25,200 cubic yards; immediately above Lock No. 1, 8,000 cubic yards; in Pool No. 1, at Turtle Creek bar, a few hundred yards below Lock No. 2, 19,000 cubic yards; head of Pool No. 2, in the approach to the locks at Dam No. 3, 15,725 cubic yards; pool No. 3, shore bar below Lock No. 4, 3,825 cubic yards; upper inlet of Lock No. 4, 1,800 cubic yards; excavation for crib along the shore above Lock No. 4, 6,000 cubic yards; bar at mouth of Dunlaps Creek, opposite Brownsville, Pa., fourth pool, 11,225 cubic yards; approaches to Lock No. 5 and shoals below it to Watkins Run, a distance of one-half mile, 20,725 cubic yards; at lower approach to Lock No. 8, 2,600 cubic yards; making a total of 117,900 cubic yards. With the exception of the work done below Lock No. 4, at Dunlaps Creek, and part of that at Watkins Run, the material was easy to excavate. At Dunlaps Creek, and in places above Watkins Run, the contractor used dynamite occasionally to loosen the material. At Turtle Creek a considerable percentage of furnace cinder and waste from coal mines was mixed with the river gravel. It is proposed to reduce the necessity for dredging at this place by the construction of a dike to deflect the water of the creek downstream along an unused shore.

Snagging.—During the year the repair steamer *Slackwater* removed from the channel of the river 368 snags. None were reported in the first pool, three-fourths of the snags being found in the fourth, fifth, and sixth pools. All of the snags were removed to the river bank, cut up, and burned.

Removal of obstructive wrecks.—Between December, 1897, and June, 1898, 19 wrecks were removed from the channel of the river between Pittsburg and Lock No. 5, classified as follows: Four steamboats, 2 of which were raised and repaired by their owners; 6 loaded coal boats, involving loss of about 5,500 tons of coal; 2 loaded and 7 empty flatboats. Several of the flatboats which sunk in or near the locks were raised and repaired by their owners, though all the coal boats and a majority of the flatboats were abandoned and entirely broken up by the dredge boats. It was not found economical to try to save any of the sunken coal, and the hulls, after being torn up, were transferred to the shore and burned. Not for many years past were there so many boats sunk in the Monongahela as were reported for the year just closed. Several of the wrecks had been in the river for a number of years. Most of the disasters were the result of boats breaking loose from their moorings during sudden freshets.

Assistant Engineer T. P. Roberts and Overseer George S. Nutt

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were engaged upon the repairs and channel works and rendered valuable service. Assistant Engineer Philip Golay, in addition to other duty, helped upon the repairs of and operating the three upper locks and dams.

Money statement.

July 1, 1897, balance unexpended	$15,120.59
Amount allotted for fiscal year 1898	132,930.36
	148,050.95
June 30, 1898, amount expended during fiscal year	105,986.72
July 1, 1898, balance unexpended	42,064.23
July 1, 1898, outstanding liabilities	23,535.16
July 1, 1898, balance available	18,529.07
Amount (estimated) for expenditure in fiscal year ending June 30, 1899	197,627.93
Amount available for fiscal year ending June 30, 1899	239,692.16

Appropriations for condemnation and purchase of improvements on Monongahela River.

August 11, 1888, costs of condemnation, Lock and Dam No. 7, Monongahela River, Pennsylvania	*$5,000.00
September 19, 1890, costs of condemnation, Lock and Dam No. 6, Monongahela River, Pennsylvania	†5,000.00
August 11, 1888, purchase of Upper Lock and Dam (No. 7), Monongahela River	†161,733.13
September 19, 1890, purchase of Upper Lock and Dam (No. 6), Monongahela River	†162,000.00
June 3, 1896, cost of condemnation property of Monongahela Navigation Company	*5,000.00
June 3, 1896, award for property of Monongahela Navigation Company.	‡3,761,615.46
Total	4,100,348.59

Allotments for operation and care of locks and dams.

August 15, 1884	$1,000.00	November 6, 1889	$1,200.00
September 1, 1884	4,000.00	July 24, 1890	12,300.00
November 3, 1884	4,500.00	July 8, 1891	24,250.00
December 20, 1884	500.00	July 21, 1892	34,017.86
June 1, 1885	100.00	July 21, 1893	23,574.72
July 22, 1885	1,000.00	July 23, 1894	25,664.00
July 10, 1886	1,200.00	July 12, 1895	20,372.40
March 1, 1887	1,100.00	July 28, 1896	19,232.84
July 1, 1887	11,000.00	July 15, 1897	§13,070.87
July 11, 1888	6,270.00	August 2, 1897	‖119,734.49
October 27, 1888	3,000.00	October 8, 1897	125.00
July 17, 1889	1,480.00		
October 7, 1889	1,500.00	Total	330,192.18

* Partly applied.
† Not applied.
‡ $120,000 of this is retained by the United States as security for the cancellation of certain outstanding bonds issued by the company.
§ Locks 8 and 9.
‖ Locks 1 to 7, inclusive.

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9 in the Monongahela River, West Virginia and Pennsylvania, during the fiscal year 1898, as required by section 4 of the river and harbor act of July 5, 1884.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
July	2	Hired men	Services, June, 1897	$550.00
	4	John C. O'Donnell, postmaster	Lock box rent	3.00
	5	Chas. Gulents	Traveling expenses	7.87
	8	Maj. Chas. F. Powell	Mileage	1.44
	9	do	do	.40
	11	do	do	12.24
	15	W. J. Gilmore & Co	Asphaltum	2.40
	16	Houston Bros	Chimney tops	7.66
	17	McClintock & Irvine	Grease	7.15
	24	The Central Dist. and Ptg. Tel. Co	Telephone service	31.25
	27	Brock, Reed & Wade	Rent, heat, and light	84.50
	28	Baker Chain and Wagon Iron Manufacturing Co.	Chains	63.07
	29	C. Hoting & Sons	Oat straw	13.10
	31	Waterbury Rope Co	Rope	53.02
	33	The Myers & Shinkle Co	Printing	8.75
	34	do	Blanks	23.00
	35	Waverly Oil Works	Oils	9.58
	36	Wm. G. Johnston & Co	Stationery	52.00
	37	do	do	12.00
	40	Maj. Chas. F. Powell	Mileage	8.28
	42	Wilson, Bailey & Co	Rope	27.48
	43	Waverly Oil Works	Oils	23.14
	45	Jos. Eichbaum & Co	Stationery	15.00
August	2	Hired men	Services, July, 1897	550.00
	9	do	do	1,088.71
	10	do	do	724.96
	11	do	Services, July and August	27.50
	12	do	Services, July, 1897	95.83
	13	do	do	719.83
	14	do	do	80.50
	15	do	do	64.17
	16	do	do	20.00
	17	do	do	38.33
	19	Bindley Hardware Co	Hardware	5.15
	21	Chas. Gulents	Traveling expenses	4.04
	22	J. H. Mahoney	Registry stamps	.96
	25	John Shoup & Co	Hemlock and oak	576.83
	26	Jos. Eichbaum & Co	Stub file books	8.00
	31	Scaife Foundry and Machine Co	Key and sheaves	37.75
	35	T. F. Pennington	Labor and material	5.22
	36	Murray Bros	Sewer pipe	32.60
	37	J. Carroll Barr	Traveling expenses	.30
	38	Jno. Austen McCulloch	do	11.84
	39	Thomas P. Roberts	do	40.58
	40	Somers, Fitler & Clarke, Limited	Boat spikes, etc	8.65
	41	Blythe & Co	Lumber	305.79
	45	The Western Union Telegraph Co	Telegram	.20
	46	M. Lans & Sons	Bolts	203.03
	47	Brown & Co., Incorporated	Iron	42.22
September	1	Hired men	Services, August, 1897	285.00
	3	do	do	108.33
	8	do	Services, July, 1897	46.00
	9	do	Services, August, 1897	4.37
	10	do	do	660.00
	11	do	do	758.33
	12	do	do	500.00
	13	do	do	450.00
	14	do	do	125.00
	15	do	do	105.00
	16	do	do	697.05
	19	do	Services, July and August	101.67
	20	do	do	220.83
	21	do	Services, August, 1897	1,067.17
	22	do	do	193.17
	23	do	do	14.88
	24	do	Services, September, 1897	6.65
	31	Thomas P. Roberts	Traveling expenses	11.04
	32	Pittsburg White Metal Co	White metal	32.72
	33	Scaife Foundry and Machine Co	Racks	3.25
	34	Waterbury Rope Co	Rope	4.40
	35	Waverly Oil Works	Oil	4.04
	36	Frank Fertig & Co	Portland cement	29.52
	37	Thos. Wightman Co	Glass	.12
	39	W. S. Evans	Labor and material	108.00
	40	Taylor Burner and Electro Plating Co., Limited.	do	68.25

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
September.	41	Brown & Co., Incorporated	Iron	$2.81
	42	....do	Iron and steel	153.86
	43	Frank Fertig & Co	Portland cement	15.30
	45	Jas. C. Lindsay Hardware Co	Nails and bolts	13.28
	47	Iron City Sand Co	Gravel	18.00
	48	The Fairbanks Co	Cock	8.40
	49	Philadelphia Co	Natural gas	1.49
	50	Atlantic Refining Co	Oil	11.33
	51	Manufacturers' Natural Gas Co	Natural gas	182.38
	53	Geo. W. Lewis	Signal oil	14.50
	54	The Eureka Ice Co	Ice	4.40
	55	W. J. Gilmore & Co	Linseed oil, etc	42.24
	56	....do	Brimstone	6.92
	58	John Shoup & Co	Lumber	436.01
	59	Oil Well Supply Co	Pipe connection	.36
	63	Bindley Hardware Co	Shovel	.50
	65	Waterbury Rope Co	Rope	161.10
	66	Wm. G. Johnston & Co	Stationery	27.65
	68	Waverly Oil Works	Oil	4.24
	69	Wolff, Lane & Co	Hardware	1.21
	70	....do	Hand-saw blades	3.00
	71	....do	Shovels	6.00
	73	Scaife Foundry and Machine Co., Limited.	Labor and material	177.00
	74	....do	....do	27.50
	75	Jos. Eichbaum & Co	Record books, etc	46.40
	76	Wm. E. Stieren	Tracing cloth	6.45
	77	Jas. H. Matthews & Co	Stencil	4.80
	79	Somers, Fitler & Clarke, Limited	Spikes and nails	84.58
	81	Second Avenue Traction Co	Car tickets	5.00
	82	Maj. Chas. F. Powell	Mileage	8.28
	85	Crescent Coal Co	Slack	153.05
	88	Somers, Fitler & Clarke, Limited	Files	7.39
	89	Caskey Boat Store Supply Co	Brooms, etc	14.60
	90	....do	Oars	6.37
	91	Wolff, Lane & Co	Padlocks, etc	29.83
	92	Allen Kirkpatrick & Co	Oil tanks	18.50
	93	Bair & Gazzam Manufacturing Co	Bolts, etc	25.50
	94	Taylor, Wilson & Co., Limited	Friction drum, etc	61.00
	95	Pennsylvania Tube Works	Pipe and ell	2.68
	100	Keystone Lumber Co	Lumber	138.82
	101	....do	Pine	17.72
	103	Logan-Gregg Hardware Co	Sledges, etc	12.36
	105	C. Hoting & Sons	Straw	8.65
	106	Bindley Hardware Co	Scythe, etc	.80
	107	Mackey Print Paper Co	Blue-print paper	3.75
	108	James C. Lindsay Hardware Co	Hardware	.79
	109	Frank Fertig & Co	Portland cement	14.52
	111	Waverly Oil Works	Oil	3.38
	112	Howe Scale Co	Scale	25.95
	116	Pgh., Brownsville & Gen. Packet Co.	Ticket	1.15
	119	W. H. Brown's Son	Hemlock and oak	27.52
	120	J. Herbertson's Sons	Labor and material	9.30
	121	Capt. E. Robison	Towing	6.00
	123	Sunlight Co	Burners	13.20
	124	John Robson & Son	Repairing chain	.50
	125	J. L. McFeeters	Traveling expenses	4.97
	126	Bindley Hardware Co	Brooms, etc	13.46
	128	Chas. A. Turner	Labor and material	150.20
	131	Chas. Gulents	Traveling expenses	1.97
	133	Hired men	Services, September, 1897	14.17
		Holyoke Envelope Co	Envelopes	4.60
October	3	Hired men	Services, September, 1897	325.00
	7	John C. O'Donnell, postmaster	Lock-box rent	3.00
	8	Hired men	Services, October, 1897	23.75
	16	....do	Services, September, 1897	660.00
	17	....do	....do	39.33
	18	....do	....do	818.34
	19	....do	....do	500.00
	20	....do	....do	500.00
	21	....do	....do	125.00
	22	....do	....do	105.00
	23	....do	....do	947.55
	24	....do	....do	1.52
	25	Philadelphia Co	Fuel gas	1.58
	29	Hired men	Services, September, 1897	70.00
	30	....do	....do	1,070.00
	31	....do	Services, September and October.	53.40

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
October....	32	Hired men	Services, September, 1897	$1,002.50
	33	.....do	Services, September and October.	24.32
	38	The Morris & Bailey Steel Co	Ashes	9.00
	39	J. Carroll Barr	Traveling expenses	.91
	40	Atlantic Refining Co	Freight	.25
	41	H. H. Bulger	Papering	16.00
	42	The Totten & Hogg I. & S. Foundry Co.	Racks	6.50
	44	Gas Engine and Power Co	Valve shafts, etc	13.05
	45	J. W. Coyle	Services, September, 1897	1.00
	67	J. L. McFeeters	Traveling expenses	4.30
	68	The Cent. Dist. & Prtg. Tel. Co	Telephone service	31.25
	69	Wm. G. Johnston & Co	Carbon sheets	.50
	72	Tide Coal Co	Towing	3.00
	73	Manufacturers' Natural Gas Co	Fuel gas	77.90
	74	The Eureka Ice Co	Ice	2.40
	75	McClintock & Irvine	Paint	1.75
	76	Waverly Oil Works	Oil	2.42
	77	C. Hoting & Sons	Straw	1.80
	78	Boon & Hill	Labor and material	86.00
	79	J. H. Mahoney	Registry stamps	1.92
	80	Crescent Coal Co	Coal	35.00
	85	Jonas Crowthers	.... do	29.00
	87	Brock, Reed & Wade	Rent and light	33.00
	88	W. H. Brown's Son	Hire of boat	125.00
	89	The Hartley Rose Belting Co	Packing	10.13
	92	G. G. O'Brien	Painting	70.00
	94	Atlantic Refining Co	Naphtha	31.20
	95	Geo. Vanderslice	Lanterns	2.00
	96	Thomas P. Roberts	Traveling expenses	28.26
	97	H. Gerwig & Sons	Oakum	11.30
	98	Frank Fertig & Co	Portland cement	4.20
	100	Williams & Reppert	Pipe, etc	9.66
	101	John A. Wood & Son	Labor and material	67.75
	102	John Crouch	Stone	61.44
	105	Somers, Fitler & Clarke, Limited	Driftbolts	9.73
	106	Knob Coal Co	Dynamite	9.00
	107	C. Jutte & Co	Dredging	1,453.50
	108	Pgh., Brownsville & G. Pkt. Co	Freight	6.27
	109	The Western Union Telegraph Co	Telegrams	.66
	110	Reno's Day Line Packet	Towing, etc	62.35
	111	J. Herbertson's Sons	Labor and material	116.40
	113	Hired men	Services, October, 1897	97.00
November.	2	.....do	.....do	325.00
	5	.....do	.....do	660.00
	6	.....do	.....do	818.33
	7	.....do	.....do	500.00
	8	.....do	.....do	500.00
	9	.....do	.....do	125.00
	10	.....do	.....do	105.00
	11	.....do	.....do	971.85
	13	.....do	.....do	1,215.60
	20	.....do	.....do	930.00
	21	.....do	.....do	44.50
	23	Maj. Chas. F. Powell	Mileage	.88
	27	Philadelphia Co	Fuel gas	3.15
	28	Hired men	Services, October, 1897	77.00
	29	Logan, Swift & Brigham Envelope Co.	Envelopes	4.86
	30	Jas. H. Gamble	Coal	35.00
	46	J. L. McFeeters	Traveling expenses	4.00
	56	Hired men	Services, November, 1897	40.00
	70	Waverly Oil Works	Oils	6.00
	83	C. M. Eichenlaub	Chair seats, etc	2.75
	84	The Manufacturers' Natural Gas Co.	Fuel gas	99.00
	85	Meeren Bros. & Co	Drills	6.14
	86	Somers, Fitler & Clarke, Limited	Boat spikes	15.16
	87	C. G. Hussey & Co	Copper	3.37
	88	Wm. G. Johnston & Co	Blanks	21.00
	89	John Shoup & Co	Hemlock	12.93
	90	Mackey Print Paper Co	Blue-print paper	7.50
	91	The Pittsburg Gas Co	Gas	3.50
	92	Reno's Day Line Packet	Towing	77.00
	93	Simeon McClain, jr	Stone	554.00
	94	A. D. Miller's Sons Co	Oil	14.72
	95	Frank Kysor	Lumber	27.45
	96	Alex. H. Tait	Timber	20.68
	97	H. L. Childs & Co	Asbestus	1.00
	98	John Crouch	Stone	59.51
	99	John Evans	Boiler inspection	6.00

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
November.	100	Brown & Co., Incorporated	Iron	$75.95
	101	J. F. Matter & Co	Labor and material	21.00
	102	C. Hoting & Sons	Straw	1.55
	103	J. Herbertson's Sons	Wire, etc	5.95
	104	A. Bradley & Co	Stove bowl	4.15
	105	Maj. Chas. F. Powell	Mileage	.88
	112	McClintock & Irvine	Iron paint	12.25
	113	Lock No. 4 Natural Gas Co	Natural gas	17.76
	114	Pittsburg Plate Glass Co	Dredging	382.76
	115	S. M. Walton & Sons	Oak and pine	268.46
	126	The Central Dist. & Prtg. Tel. Co	Telephone	28.82
	127	Jacob Kline	Stone and sheeting	554.80
	128	Monongahela Navigation Co	Oak	453.50
	129	Geo. W. Lewis	Oil	7.25
	130	Hired men	Services, November, 1897	107.33
	131	Wm. G. Johnston & Co	Stationery	11.74
	132	.....do	.....do	36.77
	133	Western Union Telegraph Co	Telegrams	.66
	136	H. D. O'Neil	Slack	64.75
	141	C. Jutte & Co	Dredging	2,061.50
	143	Shook-Anderson Manufacturing Co	Arch (hand hole)	.50
	146	Hired men	Services, November, 1897	85.00
December.	1	Baltimore and Ohio Railroad	Transportation	.35
	5	Hired men	Services, November, 1897	85.00
	7	.....do	.....do	660.00
	8	.....do	.....do	818.33
	9	.....do	.....do	500.00
	10	.....do	.....do	500.00
	11	.....do	.....do	125.00
	12	.....do	.....do	114.80
	13	.....do	.....do	375.00
	14	Pgh., Brownsville & G. Pkt. Co	Transportation	2.55
	23	Philadelphia Co	Fuel gas	6.08
	25	Hired men	Services, November, 1897	1,224.50
	26	.....do	.....do	832.17
	27	.....do	.....do	70.00
	28	.....do	.....do	904.35
	42	Emerson Kline	Oak	48.00
	46	Hired men	Services, December, 1897	49.00
	47	.....do	Services, November, 1897	15.60
	48	Geo. C. Michener	Stone	123.79
	49	C. Jutte & Co	Dredging	20.00
	50	.....do	.....do	1,520.00
	51	Thomas P. Roberts	Traveling expenses	12.97
	62	A. D. Miller's Sons Co	Oil	28.42
	64	The Nicola Bros. Co	Oak	663.63
	66	Wm. G. Johnston & Co	Stationery	12.10
	69	The Myers & Shinkle Co	Blanks	7.12
	70	William Russell	Traveling expenses	1.25
	71	Waterbury Rope Co	Rope	686.88
	72	John Robson & Son	Links	7.50
	73	J. Herbertson's Sons	Casting	14.36
	74	R. Munroe & Son	Ash pan	12.25
	75	Knob Coal Co	Coal	38.50
	76	Posey & Sebolt	Towing	6.00
	77	William G. Johnston & Co	Blanks	21.00
	78	Jeremiah Smith	Coal	22.50
	79	Pitts., McK. & Eliz. Packet Co	Towing	5.00
	81	S. Keighley & Co	Galvanized iron	31.02
	82	The Manufacturers' Natural Gas Co	Fuel gas	101.10
	83	M. Lanz & Sons	Spikes	15.33
	85	Jacob Provins	Oak	18.11
	86	Geo. W. Rush	Stone	137.80
	90	Hired men	Services, December, 1897	436.07
	98	Waverly Oil Works	Oils	10.08
	99	Dauler, Close & Johns	Furniture	23.65
	100	A. Bradley & Co	Stoves, etc	16.01
	101	J. L. McFeeters	Traveling expenses	3.65
	102	H. Childs & Co	Hose, packing, etc	130.44
	103	D. Hastings	Labor and material	2.50
	104	J. Herbertson's Sons	Irons	111.36
	107	Somers, Fitler & Clarke, Limited	Nails, etc	23.13
	108	Chas. Gulentz	Reimbursement	.75
	109	John Shoup & Co	Lumber	958.88
	110	Scaife Foundry and Machine Co., Limited.	Shafting, etc	70.17
	111	Reno's Day Line Packet	Freight	3.00
	112	The Western Union Telegraph Co	Telegrams	.20
	114	Hired men	Services, December, 1897	45.00

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
December..	115	Hired men	Services, December, 1897	$450.00
	116	Pgh. Brownsville & G. Pkt. Co	Freight	10.18
	117	Frank Kysor	Towing	5.00
	118	J. Herbertson's Sons	Labor and material	17.36
	119	Hired men	Services, December, 1897	85.00
1898.				
January...	5	John C. O'Donnell, postmaster	Lock-box rent	3.00
	6	Hired men	Services, December, 1897	660.00
	7	....do	....do	813.34
	8	....do	....do	500.00
	9	....do	....do	500.00
	10	....do	....do	125.00
	11	....do	....do	105.00
	12	....do	....do	884.25
	13	....do	....do	270.00
	14	....do	....do	19.76
	15	....do	....do	1,127.17
	16	....do	....do	70.00
	28	John C. O'Donnell, postmaster	Registry stamps	1.92
	32	Philadelphia Co	Fuel gas	6.30
	33	Jacob Provins	Oak	6.33
	34	Wm. J. Coleman	Stone	679.51
	35	James Lappan & Co	Repairing boilers	16.33
	48	Wm. G. Johnston & Co	Record books	3.36
	49	The Manufacturers' Natural Gas Co	Fuel gas	129.48
	50	J. L. McFeeters	Traveling expenses	4.78
	51	William Russell	....do	3.98
	52	C. Jutte & Co	Dredging	1,250.00
	53	....do	....do	750.50
	61	James B. Hill	Pine, etc	110.77
	62	H. C. Baker	Stovepipe	1.05
	64	Graff & Co	Gas burners	15.00
	65	Brock, Reed & Wade	Rent, heat, and light	37.50
	66	A. Bradley & Co	Stovepipe, etc	2.62
	67	Duncan & Porter	Portland cement	6.75
	68	J. Herbertson's Sons	Labor and material	10.50
	69	Pgh., Brownsville & G. Pkt. Co	Freight	2.05
	70	Somers, Fitler & Clarke, Limited	Cap screws	1.65
	72	T. F. Pennington	Labor and material	14.96
	73	Doubleday Electrical Co	Carbons	17.00
	74	Wolff, Lane & Co	Iron and wicks	6.43
	75	Thos. Wightman Co	Lights	.60
	76	M. Lanz & Sons	Spikes	34.63
	77	The Cent. Dist. & Prtg. Tel. Co	Telephone service	62.50
	78	Samuel McKnight	Hardware	11.78
	79	....do	....do	21.39
	80	....do	....do	25.39
	83	Hired men	Services, January, 1898	85.00
February..	1	....do	....do	44.50
	2	Thomas P. Roberts	Traveling expenses	25.71
	3	Hired men	Services, January, 1898	450.00
	8	United States Express Co	Freight	.30
	9	Hired men	Services, January, 1898	660.00
	10	....do	....do	818.33
	11	....do	....do	500.00
	12	....do	....do	500.00
	13	....do	....do	125.00
	14	....do	....do	105.00
	15	....do	....do	704.70
	16	....do	....do	1,425.00
	18	Maj. Chas. F. Powell	Mileage	3.12
	19	Caskey Boat Store Supply Co	Tarpaulins, etc	69.84
	20	Somers, Fitler & Clarke, Limited	Brooms, etc	29.35
	21	....do	....do	15.59
	22	....do	....do	36.21
	23	....do	....do	7.05
	24	....do	Oil pumps, etc	13.90
	25	A. D. Miller's Sons Co	Oil	21.49
	26	George A. Kelly Co	Brimstone	26.11
	27	Bindley Hardware Co	Hardware	8.19
	28	....do	....do	44.26
	29	....do	Chains	270.95
	30	....do	Lamps	10.05
	31	Logan-Gregg Hardware Co	Nails, etc	20.30
	32	....do	....do	24.25
	33	....do	....do	72.10
	34	....do	....do	5.85
	36	....do	....do	8.25
	37	Alps Coal Co	Coal	100.60

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
February ..	38	Joseph Woodwell & Co	Bolts	$4.00
	39	Graff & Co	Fire chambers, etc	12.60
	40	U. Baird Machinery Co	Iron tuyeres	8.00
	41	C. Jutte & Co	Removing obstructions	420.00
	42	.....do	Dredging	446.50
	43	Manufacturers' Natural Gas Co	Fuel gas	94.50
	44	Robbins Electric Co	Sal ammoniac	.40
	45	J. L. McFeeters	Traveling expenses	7.35
	46	William Russell	.....do	2.10
	47	The Pittsburg Gas Co	Gas	8.70
	53	Jas. H. Matthews & Co	Dies and brands	2.89
	54	Waverly Oil Works	Oils	9.51
	55	.....do	.....do	14.48
	56	Reno's Day Line Packet	Freight	2.50
	60	Philadelphia Company	Fuel gas	9.00
	61	Bindley Hardware Co	Bolts, etc	64.46
	62	Logan-Gregg Hardware Co	Lamps	1.73
	63	Geo. S. Nutt	Traveling expenses	1.70
	64	.....do	.....do	3.91
	65	M. Lanz & Sons	Spikes	7.55
	66	.....do	.....do	438.10
	67	Bair & Gassam Manufacturing Co	Repairing engines	165.75
	68	.....do	.....do	51.25
	69	Jos. Eichbaum & Co	Blanks	37.00
	70	Wylie Bros	Repairs (lock house)	7.00
	71	The Cent. Dist. & Prtg. Tel. Co	Telephone service	7.75
	72	A. Klicker	Dike	1,960.06
	73	Lock No. 4 Natural Gas Co	Gas	33.73
	74	Caskey Boat Store Supply Co	Oars	6.35
	75	Hired men	Services, January, 1898	39.52
	76	Joseph Woodwell & Co	Forge	12.75
	77	Logan-Gregg Hardware Co	Hardware	12.48
	79	The Western Union Telegraph Co	Telegrams	.55
	80	Maj. Chas. F. Powell	Mileage	2.04
	81	John Shoup & Co	Pine	40.48
	83	Blythe & Co	Pine and oak	98.97
	85	Nicola Bros. Co	Fir lumber	585.72
	86	Chas. Gulents	Traveling expenses	2.24
	87	Waverly Oil Works	Oils	17.64
	89	Hired men	Services, February, 1898	85.00
March.....	1	.....do	.....do	450.00
	5	.....do	.....do	660.00
	6	.....do	.....do	818.33
	7	.....do	.....do	500.00
	8	.....do	.....do	500.00
	9	.....do	.....do	115.00
	10	.....do	.....do	1,355.00
	11	.....do	.....do	28.00
	12	.....do	.....do	125.00
	18	.....do	.....do	676.20
	15	Wm. G. Johnston & Co	Stationery	6.05
	16	Samuel McKnight	Vise	4.20
	17	S. S. Crump & Co	Hire of boat	65.00
	21	Hired men	Services, February, 1898	36.48
	23	The Cent. Dist. & Prtg. Tel. Co	Telephone service	11.45
	24	Bindley Hardware Co	Hardware	8.43
	28	Logan, Swift & Brigham Envelope Co	Envelopes	12.00
	30	Imri N. Lucas	Traveling expenses	5.76
	31	Steamer Nellie Hudson	Freight	4.50
	32	T. M. Jenkins & Co	Coal	36.89
	33	A. D. Miller's Sons Co	Oil	9.85
	34	Philadelphia Company	Fuel gas	9.68
	35	T. F. Pennington	Grates	2.46
	36	William Russell	Traveling expenses	1.35
	37	J. L. McFeeters	.....do	4.95
	38	The Manufacturers' Natural Gas Co.	Fuel gas	36.60
	39	Benjamin F. Gabler	Coal	4.00
	40	Gas Engine and Power Co. and Chas. L. Seabury & Co., Consolidated.	Pinion, stud, etc	1.10
	41	Geo. S. Nutt	Traveling expenses	5.13
	42	James T. Nutt	.....do	2.93
	43	Wm. G. Johnston & Co	Writing pads	18.40
	44	C. Jutte & Co	Dredging	1,406.00
	45	.....do	Removing obstructions	10.00
	46	Crow Bros	White oak	842.45
	47	Oil Well Supply Co	Pipe, etc	2.51
	49	Baltimore and Ohio R. R. Co	Transportation	.22
	50	P. & M. Packet Co	Freight	.40
	51	Jackson R. Stoker	Use of ice harbor	10.00

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
March	52	J. W. Coyle	Services, February, 1898	$4.00
	53	W. J. Gilmore & Co	Sperm oil	1.65
	54	The Western Union Telegraph Co	Telegrams	1.11
	55	The Cent. Dist. & Prtg. Tel. Co	Telephone service	7.00
	56	Jones & Laughlins, Limited	Driftbolts	133.81
	57	Reno's Day Line Packet	Freight	1.00
	58	Jas. H. Matthews & Co	Rubber stamps	1.10
	59	Wm. G. Johnston & Co	Binding	2.00
	60	Adams Express Co	Freight	.30
	61	Consolidated Traction Co	Car tickets	10.00
	63	The Pittsburg and Lake Erie R. R. Co.	Transportation	1.26
	64	Davis Bros	Hire of team	3.00
	65	Chas. Gulentz	Traveling expenses	2.24
	66	Hired men	Services, March, 1898	85.00
April	4	do	do	450.00
	5	John C. O'Donnell, postmaster	Lock-box rent	3.00
	6	Scaife Foundry and Machine Co., Limited.	Miter wheels	48.50
	7	J. Herbertson's Sons	Casting	7.87
	8	Thomas P. Roberts	Traveling expenses	10.88
	10	The Cent. Dist. & Prtg. Tel. Co	Telephone service	62.50
	11	Brock, Reed & Wade	Rent, heat, and light	37.50
	12	Pennsylvania R. R. Co	Transportation	1.84
	13	The Manufacturers' Natural Gas Co.	Fuel gas	59.40
	14	H. Childs & Co	Rubber boots	16.88
	15	Hired men	Services, March, 1898	660.00
	16	do	do	500.00
	17	do	do	500.00
	18	do	do	45.00
	19	do	do	125.00
	20	do	do	695.40
	22	William Russell	Traveling expenses	3.31
	23	Phillips, Nimick & Co	Iron	412.15
	24	Geo. S. Nutt	Traveling expenses	3.63
	25	Hired men	Services, March, 1898	3.33
	27	John C. O'Donnell, postmaster	Registry stamps	1.92
	28	Hired men	Services, March, 1898	818.34
	30	Jno. Austen McCulloch	Traveling expenses	9.90
	31	Caskey Boat Store Supply Co	Oars	1.80
	32	Wm. G. Johnston & Co	Stationery	8.50
	33	J. L. McFeeters	Traveling expenses	6.11
	44	C. Jutte & Co	Dredging	574.75
	45	do	Removing obstructions	40.00
	47	Lock No. 4 Natural Gas Co	Gas	32.68
	48	Hired men	Services, March, 1898	115.00
	49	do	do	1,350.34
	51	The Western Union Telegraph Co	Telegrams	2.26
	55	Philadelphia Company	Gas	4.50
	56	W. A. Scott, jr	Brick, etc	5.50
	57	The Manufacturers' Natural Gas Co.	Burner	16.00
	58	Waverly Oil Works	Oils	.75
	59	Scaife Foundry and Machine Co., Limited.	Miter wheel	7.25
	60	Samuel McKnight	Tools	28.32
	61	Brown & Co., Incorporated	Iron	450.42
	62	Somers, Fitler & Clarke, Limited	Screw ends, etc	124.36
	63	W. H. Brown's Son	Oak and pine	213.09
	64	Pgh., Brownsville & G. Pkt. Co	Freight	1.50
	65	Maj. Chas. F. Powell	Mileage	4.40
	67	John Shoup & Co	Oak	458.81
	70	A. D. Miller's Sons Co	Oils	27.88
	76	Geo. C. Michener	Stone	153.83
	77	J. E. Kennelly	Rice	3.00
	78	Reno's Day Line Packet	Towing	12.00
	79	Hired men	Services, April, 1898	54.00
	80	B. F. Gabler	Coal	4.00
	81	S. Keighley & Co	Tin work	69.70
	82	Jos. Eichbaum & Co	Record books	12.34
	83	Alpe Coal Co	Coal	73.20
	84	W. J. Gilmore & Co	Whitewash brushes, etc	13.38
	85	The Cent. Dist. & Prtg. Tel. Co	Telephone service	6.80
	88	Hired men	Services, April, 1898	545.00
	89	do	do	450.00
May	2	Israel L. Roseberry	Traveling expenses	1.98
	3	Simeon McClain, jr	Towing	5.00
	4	Patterson & Co	Lime	10.10
	5	Hired men	Services, April, 1898	660.08
	6	do	do	500.00
	7	James McKay & Co	Chain	5.45

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
May	8	Hired men	Services, April, 1898	$1,374.00
	9	.....do	.....do	685.80
	13	.....do	.....do	818.33
	14	.....do	.....do	500.00
	15	.....do	.....do	115.00
	18	.....do	.....do	165.00
	19	The Western Union Telegraph Co	Telegrams	.50
	20	Adams Express Co	Freight	1.25
	21	S. H. Hathaway, quartermaster, U. S. A.	Flags	24.84
	24	Hired men	Services, April, 1898	45.00
	25	.....do	.....do	70.00
	26	C. Jutte & Co	Dredging	1,066.38
	27	.....do	Removing obstructions	55.00
	28	William Russell	Traveling expenses	7.14
	29	J. L. McFeeters	.....do	5.38
	30	I. N. Weaver	Oak	168.54
	31	Pennsylvania R. R. Co	Transportation	2.57
	39	Wm. G. Johnston & Co	Books, etc	5.70
	40	Pgh., Brownsville & G. Pkt. Co	Freight	17.51
	41	The Manufacturers' Natural Gas Co	Gas	64.95
	42	The Pittsburg Gas Co	.....do	5.80
	43	Geo. S. Nutt	Traveling expenses	7.69
	44	W. H. Brown's Son	Hire of boat	87.50
	45	Philadelphia Co	Gas	4.95
	46	James T. Nutt	Traveling expenses	1.15
	48	Oil Well Supply Co	Supplies	.55
	55	Bindley Hardware Co	Kettles, etc	9.75
	56	A. D. Miller's Sons Co	Oil	23.68
	57	Waverly Oil Works	Oils	8.00
	58	Pgh., Brownsville & G. Pkt. Co	Freight	.60
	59	Caskey Boat Store Supply Co	Salt	.90
	60	C. A. Turner	Belt	2.91
	61	Jas. B. Haines & Sons	Duck	48.95
	62	W. J. Gilmore & Co	Yellow ocher	30.19
	63	McClintock & Irvine	Linseed oil	30.28
	64	Jones & Laughlin, Limited	Angle irons	19.38
	65	Somers, Fitler & Clarke, Limited	Copper tacks	3.60
	66	J. Herbertson's Sons	Suspension bars	156.48
	67	.....do	Anchors	32.10
	68	.....do	Hoods, etc	46.00
	69	Elizabeth Marine Ways Co	Oak	982.70
	70	The Cent. Dist. & Prtg. Tel. Co	Telephone service	3.35
	71	Reno's Day Line Packet	Towing, etc	13.00
	75	S. P. Hatfield	Services, May, 1898	175.00
	76	Caskey Boat Store Supply Co	Pumps	24.90
	77	Western Union Telegraph Co	Telegrams	.26
	78	Chas. Gulentz	Traveling expenses	2.79
	79	J. D. McIlroy & Sons	Lamps	6.00
	80	Hired men	Services, May, 1898	514.00
	81	.....do	.....do	545.60
June	2	T. J. Barnard	Oak, etc	1,068.77
	5	Hired men	Services, May, 1898	660.00
	6	.....do	.....do	818.33
	7	.....do	.....do	500.00
	8	.....do	.....do	173.33
	9	.....do	.....do	1,649.34
	10	.....do	.....do	45.00
	11	.....do	.....do	75.00
	12	.....do	.....do	561.60
	14	Maj. Chas. F. Powell	Mileage	.92
	20	Hired men	Services, May, 1898	500.00
	21	.....do	.....do	115.00
	25	.....do	.....do	70.00
	37	Wolff, Lane & Co	Tools	.88
	38	Philadelphia Co	Gas	1.58
	39	Thomas P. Roberts	Traveling expenses	12.92
	40	William Russell	.....do	7.60
	41	J. L. McFeeters	.....do	5.81
	42	John Shoup & Co	Oak	337.96
	43	The Myers & Shinkle Co	Paper	2.25
	44	Stephens Bros	Repairs	120.00
	45	Scaife Foundry and Machine Co	Stud	5.90
	46	J. H. Herr	Bath tub (lock master's house).	44.16
	47	Reno's Day Line Packet	Towing	106.00
	48	Oliver C. Wilson	Stone	67.48
	49	Atwood & McCaffrey	Shafting	67.50
	50	Elizabeth Marine Ways Co	Oak, etc	461.46

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Detailed statement of expenditures made in connection with the work of operating and care of locks and dams 1 to 9, etc.—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1898.				
June.....	51	The Manufacturers' Natural Gas Co..	Gas.....	$59.40
	52	James Jones & Sons.....	Coal.....	82.25
	53	Steamer I. M. Mason.....	Hire of flat.....	16.00
	54	D. Frits.....	Repairs.....	159.70
	55	George S. Nutt.....	Traveling expenses.....	13.11
	56	Thompson & Co.....	Cambric.....	4.20
	57	Whitlach & Barcus.....	Repairs.....	210.00
	66	J. Herbertson's Sons.....	Cast irons.....	7.65
	67	.....do.....	.....do.....	49.91
	68	Geo. W. Rush.....	Stone.....	168.13
	69	C. Jutte & Co.....	Removing obstructions.....	2,475.00
	70	.....do.....	Dredging.....	76.00
	71	.....do.....	Towing.....	8.00
	72	Walton Lumber Co.....	Hemlock.....	122.50
	73	.....do.....	Weatherboarding.....	25.20
	74	.....do.....	.....do.....	26.32
	75	Frank Kysor.....	Towing.....	5.00
	76	Jacob Kline.....	Stone.....	144.30
	78	Pgh., Brownsville & G. Pkt. Co.....	Freight.....	8.08
	84	Waterbury Rope Co.....	Hand line.....	14.61
	85	C. M. Crall.....	Plastering.....	67.50
	86	George W. Rush.....	Stone.....	65.81
	87	Brown & Co., Incorporated.....	Iron.....	47.72
	89	Somers, Fitler & Clarke, Limited.....	Set screws.....	3.13
	90	W. W. Lawrence & Co.....	White lead, etc.....	44.48
	91	W. J. Gilmore & Co.....	Paint.....	.90
	92	.....do.....	Sponges.....	3.75
	94	E. H. Arrison.....	Painting and papering.....	245.00
	95	.....do.....	Glass, etc.....	3.00
	96	George C. Michener.....	Stone.....	85.94
	97	T. J. Barnard.....	Oak.....	278.76
	100	The Cent. Dist. & Prtg. Tel. Co.....	Telephone service.....	6.25
	101	John Crouch.....	Stone.....	53.61
	102	Oliver S. Wilson.....	.....do.....	148.08
	103	Frank Kysor.....	Spruce lumber.....	22.00
	104	George W. Rush.....	Stone.....	85.51
	105	George C. Michener.....	.....do.....	84.40
	106	William R. Martin.....	Oak.....	411.69
	107	William G. Johnston & Co.....	Copy books.....	1.70
	108	Scaife Foundry and Machine Co., Limited.	Heel posts.....	46.80
	109	Walton Lumber Co.....	Hemlock.....	9.80
	110	Brock, Reed & Wade.....	Rent, heat, and light.....	34.50
	113	Hired men.....	Services, June, 1898.....	474.00
	114	.....do.....	.....do.....	695.00
		Total.....	.....	105,986.72

Expended during fiscal year 1898.....	$105,986.72	
Paid outstanding liabilities fiscal year 1897.....	708.71	
		$105,278.01
Outstanding liabilities June 30, 1898.....		23,535.16
Cost of operating and care of locks and dams during past fiscal year.....		128,813.17

COMMERCIAL STATISTICS.

Two lines of daily packets, comprising five steamers, run between Pittsburg and Morgantown; three packets make week-day round trips between Pittsburg and Elizabeth or Brownsville, and two steamers make week-day round trips between points in the fourth and fifth or sixth pools.

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Classes of boats coming to Pittsburg or plying on the Allegheny or Monongahela rivers, principally the latter, compiled in 1897.

Class.	Number.	Tonnage.		Draft of water.
		Gross.	Net.	
				Feet.
Merchant steam vessels:				
Towboats	86	22,101.89	20,563.62	3 to 8
Passenger and freight boats	34	7,156.73	5,473.05	1.5 to 6.5
Dredge boats	12	1,306.89	1,033.31	3 to 4.5
Pump boats	3	22.58	22.58	2.6 to 3
Ferryboats	8	415.13	405.87	2.5 to 5.4
Pleasure steamers	19	140.81	135.77	2.5 to 4.6
Pleasure yachts	4	20.00	20.00	2.5 to 4
Launch (naphtha)	1	1.75	1.75	2.6
Unrigged merchant vessels: Decked barges	74	45,611.34	45,611.34	3 to 8
Craft not enrolled:				
Coal boats	945	993,970.00	993,970.00	6 to 8
Coal barges	1,580	825,925.00	825,925.00	6 to 7
Fuel barges	102	28,886.00	28,886.00	6 to 7
Flats:				
Coal	853	155,917.00	155,917.00	3 to 7
Sand	220	22,000.00	22,000.00	3 to 4
Skeleton barges	10	6,000.00	6,000.00	6 to 7
Total	.....	2,109,475.12	2,105,965.29	.....

Monongahela River coal traffic.

Calendar year.	Passed through locks on Monongahela River.	Passed Davis Island Dam, Ohio River, near Pittsburg (from annual report Ohio River improvement).	Difference, approximate consumption of river coal at Pittsburg.
	Tons.	*Tons.*	*Tons.*
1890	4,652,104	3,420,357	1,231,747
1891	4,276,588	2,893,752	1,382,836
1892	3,872,340	2,299,294	1,573,046
1893	3,860,072	2,364,401	1,495,671
1894	4,649,612	2,453,787	2,195,825
1895	4,183,596	2,393,873	1,789,723
1896	5,709,252	4,102,190	1,607,062
1897	5,289,838	2,670,369	2,619,469
1898 (fiscal)	5,729,110	.....	.....

REMARKS.—About 250,000 tons of river coal are estimated to have been mined on the Monongahela River in 1897 and used in the pools where mined, and consequently are not included in the amount locked. A proportionate amount, considering the yearly tonnage, applies in the same way for the other years.

Lockages made and traffic passed at Monongahela River locks during year ending June 30, 1898.

At dams.	Lockages.		Steamboats (number).		Coal boats, barges, flats, and boat bottoms (number).		Rafts (number).		Other craft (number).	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
1	10,785	10,831	8,039	8,044	11,942	12,897	414	43	1,226	896
2	10,577	10,425	6,937	6,925	15,528	16,454	243	89	875	870
3	6,614	6,841	4,542	4,564	13,787	14,270	23	102	206	201
4	6,554	6,619	4,204	4,216	11,595	11,724	22	102	164	132
5	1,875	1,993	1,633	1,639	753	723	.....	116	212	222
6	936	1,015	887	886	147	137	4	98	25	25
7	829	899	768	768	136	125	1	109	53	47
8	1,154	1,192	817	816	267	249	82	88	266	238
9	864	892	752	752	131	117	3	57	110	108
Aggregate.	40,188	40,697	28,579	28,610	54,286	56,696	792	804	3,137	2,239

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Lockages made and traffic passed at Monongahela River locks, etc.—Continued.

At dams.	Coal (tons).		Rails, steel (tons).		Other iron products (tons).		Sundry merchandise (tons).		Sand (tons).	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
1	54,012	4,733,209	24	42,622	1,328	24,904	39,467	9,565	50,892	25,886
2	29,141	5,699,969	134	.....	1,421	2,847	29,880	8,426	1,925	107,995
3	2,324	4,877,825	90	.....	1,967	113	22,502	6,981	530	20,457
4	840	3,993,384	141	12	1,808	94	18,465	6,673	5,280	3,750
5	226	126,012	30	.....	1,746	53	9,859	6,128	250	100
6	571	40	2	.....	533	55	9,011	4,448	.....	100
7	521	69	13	.....	217	117	6,559	2,887	.....	100
8	461	38	.....	.....	206	160	8,429	2,354	1	100
9	103	19	.....	.....	209	82	5,274	2,141	3,660	.....
Aggregate.	88,199	a19,430,565	434	42,634	9,435	27,925	149,446	49,596	62,538	157,988

At dams.	Gravel (tons).		Stone (tons).		Brick (number).		Timber (cubic feet).		Lumber (feet B. M.).	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
1	56,540	990	3,377	.....	.....	.....	2,400,878	170,596	9,766,740	873,850
2	5,725	500	440	3,025	617,000	.....	1,586,080	342,070	4,681,950	728,330
3	1,200	.....	.....	390	.....	.....	93,740	622,776	2,839,988	455,270
4	200	422	60	80	3,000	.....	80,000	775,416	2,262,840	537,040
5	10,796	.....	.....	3,131	.....	.....	.....	543,636	163,450	3,593,590
6	.....	.....	10	514	.....	.....	1,720	597,182	12,150	1,905,006
7	.....	.....	.....	580	.....	.....	.....	638,655	62,200	2,246,786
8	527	.....	776	.....	.....	.....	15,876	696,458	75,970	2,073,908
9	90	.....	1,300	.....	15,000	10,440	297,060	548,200	660,500	
Aggregate.	75,078	1,912	5,963	7,720	620,000	15,000	4,188,734	4,683,849	20,413,488	12,074,275

At dams.	Laths (number.)		Posts and braces (number).		Live stock, large (number).		Live stock, small (number).		Passengers (number).	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
1	1,000,000	800,000	204,260	.....	362	565	.....	2,421	76,258	76,085
2	.....	.....	217,000	300	466	619	12	2,452	78,716	78,382
3	.....	.....	117,900	800	450	704	49	2,825	47,972	48,622
4	.....	.....	150,100	800	374	689	55	2,941	29,029	29,090
5	.....	.....	.....	81,669	223	642	15	5,098	27,592	26,785
6	.....	.....	800	67,653	214	542	73	4,459	17,319	16,484
7	.....	.....	.....	38,707	164	268	18	1,165	15,495	14,399
8	.....	.....	4,759	35,654	144	221	1	1,004	15,086	14,088
9	.....	.....	.....	600	174	184	18	689	14,144	12,284
Aggregate.	1,000,000	800,000	694,819	226,183	2,571	4,434	241	23,054	321,611	316,169

a Includes small quantity of coke.

Maximum traffic, in tons, exclusive of timber and lumber, at any lock for year ending June 30, 1898.

Class.	At Lock No.—	Up.	Down.	Total.
Coal	2	29,141	5,699,969	5,729,110
Rails, steel	1	24	42,622	42,646
Other iron products	1	1,328	24,904	26,232
Sundry merchandise	1	39,467	9,565	49,032
Sand	2	1,925	107,995	109,920
Gravel	1	56,540	990	57,530
Stone	2	440	3,025	3,465
Brick	2	1,851	.....	1,851
Lath	1	17	13	30
Posts and braces	2	5,500	.....	5,500
Live stock, large	3	158	246	404
Live stock, small	5	1	255	256
Total	.....	136,392	5,889,584	6,025,976
Passengers	2	78,716	78,382	157,098

a Number.

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Bridges completed over Monongahela River and its branches.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of pool or branch in which located.
				Clear width at pool or low-water level.	Clear height above pool or low-water level.	
	Miles.			*Feet.*	*Feet.*	
Point	0	Highway	1	780	73.3	Davis Island Dam.
Smithfield street	.8	... do	2	344	55	Do.
Pittsburg, Cincinnati, Chicago and St. Louis Railway (Try street).	1	Railway ..	5	247	53	Do.
Tenth street	1.3	Highway	3	195	54	Do.
Monongahela Connecting Railway.	2.8	Railway ..	6	300	51.8	No. 1, Monongahela River.
Pittsburg (Glenwood)	5.8	Highway	3	500	53	Do.
Baltimore and Ohio (Glenwood)	6	Railway ..	8	184	57	Do.
Homestead, Ann street	7	Highway	5	350	52	Do.
Pittsburg, McKeesport and Youghiogheny (Homestead).	8	Railway ..	6	250	54	Do.
Rankin	9	Highway	3	500	55	Do.
Pennsylvania Railroad (Port Perry).	11.8	Railway ..	9	253	57	Do.
McKeesport and Duquesne	14.5	Highway	4	305	57	No. 2, Monongahela River.
McKeesport and Bessemer	14.6	Railway ..	5	325	51.5	Do.
McKeesport Suspension	15.5	Highway	3	305	43	Youghiogheny River.
Pittsburg, McKeesport, and Youghiogheny Railroad (McKeesport).	15.57	Railway ..	6	221	40	Do.
Fifth avenue and High street (McKeesport).	15.6	Highway	3	300	50	Do.
Port View	16	....do	3	258	40	Do.
Dravosburg	16.2	....do	4	350	51.8	No. 2, Monongahela River.
Boston	18	....do	3	337	45.03	Youghiogheny River.
Elizabeth	23	....do	3	350	51	No. 2, Monongahela River.
Suterville	30	....do	3	320	37	Youghiogheny River.
Monongahela City	32.5	....do	4	216	42	No. 3, Monongahela River.
Bellevernon *a*	43.5	....do	3	350	54	No. 4, Monongahela River.
Ohio and Baltimore Short Line Railroad (Greenfield).	52	Railway ..	4	238	52	No. 4, no superstructure.
Pennsylvania Railroad (Redstone).	56	....do	4	262	40	No. 4, Monongahela River.
Brownsville	57.3	Highway	3	218	41.5	Do.
State Line Railroad (Point Marion).	90.5	Railway ..	5	109	33.5	Cheat River.
Morgantown	102	Highway	1	606	45.7	No. 9, Monongahela River.
Baltimore and Ohio Railroad (near Fairmont, W. Va.).	125.5	Railway ..	.....	.....	.....	Above slack water.
Fairmont Suspension	126.5	Highway	4	190	39	Do.
Baltimore and Ohio Railroad (near Fairmont, W. Va.).	127	Railway ..	.....	.....	.....	Do.

a Records do not show that the plans of the Bellevernon Bridge were approved by the Secretary of War.

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Bridges authorized and under construction at end of year.

Place.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of pool or branch in which located.
				Clear width at pool or low-water level.	Clear height above pool or low-water level.	
	Miles.			*Feet.*	*Feet.*	
Ferry street, Pittsburg	0.5	Iron truss; railway and highway.	3	750	80	Davis Island.
South Twenty-second street, Pittsburg.[a]	2.3	Iron truss; highway	3	500	53	No. 1, Monongahela River.
Port Perry	11.7	Iron truss; railway	6	378.5	66	Do.

Place.	Date of approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by act of Congress.	Date of completion of work prescribed by act of Congress.
Ferry street, Pittsburg	Mar. 2, 1895	May 20, 1896	One year from date of act.	Three years thereafter.
South Twenty-second street, Pittsburg.	May 7, 1894	Aug. 21, 1894		
Port Perry	Jan. 26, 1897	Mar. 8, 1897		

[a] The South Twenty-second Street Bridge, Pittsburg, is completed, except that mooring rings for the use of navigators have not been inserted in the channel piers.

Bridges authorized, but whose construction or reconstruction had not been commenced at end of year.

Place.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of pool or branch in which located.
				Clear width at pool or low-water level.	Clear height above pool or low-water level.	
	Miles.			*Feet.*	*Feet.*	
South Tenth street, Pittsburg.	1.3	Iron truss, highway.	3	500	53	Davis Island.
Braddock, Thirteenth street, (1).	11.2	Iron truss, railway and highway.	3	361.3	56.7	No. 1, Monongahela River.
Braddock, Thirteenth street, (2).	11.2	Iron truss, highway.	4	500	60 to 83	Do.
McKeesport (to Mifflin Township.)	15.4	Suspension, highway.	1	700	70	No. 2, Monongahela River.
McKeesport (to Reynoldton).	15.57	Iron truss, railway	5	221	40	Youghiogheny River.
Monongahela City	32.6	.....do	3	500	53	No. 3, Monongahela River.

Place.	Date of approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by act of Congress.	Date of completion of work prescribed by act of Congress.
South Tenth street, Pittsburg.		Oct. 22, 1894[a]	One year from date of act.	Three years thereafter.
Braddock, Thirteenth street (1)	Feb. 18, 1893, amended May 4, 1896.	Oct. 2, 1896		
Braddock, Thirteenth street (2)	Jan. 26, 1897	Apr. 10, 1897		
McKeesport (to Mifflin Township).	Feb. 25, 1897	Feb. 24, 1898		
McKeesport (to Reynoldton)		Apr. 29, 1898[a]		
Monongahela City	Mar. 2, 1895	Sept. 12, 1895		

[a] For reconstructing bridge.

NOTE.—Authority for bridge over Monongahela River at Homestead (Dickson street) by the Braddock and Homestead Bridge Company has expired by limitation.

Authority for bridge over Youghiogheny River at Dawson by the Youghiogheny Central Railway Company has expired by limitation.

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GG3.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The object of this improvement is to afford open river navigation by means of contraction works and annual removal of obstructions. A history and description of the works are given in the last annual report.

At the beginning of the year the dams and dikes already built at nine localities, scattered along 200 miles of river, were in fairly good condition, except the dam, now abandoned, at Nicholsons Island. Some of the other works only required ordinary repairs due to small undermining or to displacement of paving. These repairs and the removal of bowlders and snags which had been carried into the river by ice and freshets and had lodged in the channel were undertaken. The principal part of the small balance of funds available—less than $8,000—was applied to an extension of Red Bank Dike for bettering the channel at a bad ripple there, and to the protection of the channel face of Hickory Island, which had been badly scoured as a result of contraction of the waterway by an adjacent cut-off dam, thereby threatening to spoil an improved channel.

The field work was supervised by Assistant Engineer J. W. Arras, who reports thereon that—

The delivery of materials for the extension of Red Bank Dike, contracted for, after considerable delay, began to arrive in the latter part of September. The season being far advanced, extraordinary efforts were put forth to rush the work to completion before the fall freshets set in. On September 29 a sufficient quantity of timber had been received to justify a start. Exceptionally favorable conditions enabled the work to progress rapidly, and in consequence the timber work and stone filling were practically finished in one month, and about one-fifth of the paving placed. Paving was continued until November 13, when work was suspended owing to a shortage of funds. At this time 316 linear feet of paving was all that remained to be done to complete the work.

The original dike at Red Bank projects from the right bank a little below a point opposite the mouth of Red Bank Creek, 64 miles above Pittsburg. Originally it was located farther downstream so as to reach the summit of the shallow bar at the foot of the ripple, but was changed to its present location at the request of the steamboating interests. As a result it failed largely of its purpose, the water escaping by a strong cross current toward the right bank between the foot of the dike and the bar. It was to overcome this diversion of water from the main channel that the extension of this dike was made. The new addition is 1,000 feet long, 12 feet wide, which is also the width of the lower portion of the original dike, and its average height is 7 feet, bringing it up to the plane of a 6-foot stage. In construction it is similar to the old, being a rigidly bolted timber crib work filled with broken stone and paved with hammer-dressed stone to a depth of 1 foot. Its position is a continuation of the line of the old dike with gradually diminishing curvature, nearly parallel to the left bank of the stream. It passes slightly to the right of and about 200 feet beyond the summit of the bar, effectually preventing all waste from the channel and concentrating the entire low-water discharge on the left of the bar.

The following is a statement of the material expended in this work:

White-oak lumber	feet B. M..	92,120
Hemlock lumber	do....	79,400
Driftbolts	pounds..	17,237
Riprap stone	cubic yards..	2,684
Excavation	do....	207

The cost of the extension was $6,263.37.

On September 20 three small parties, each consisting of one suboverseer, five laborers, and one to two teamsters with teams, fully equipped with blasting appliances, drag sleds, etc., for the removal of bowlders and snags from the channel, commenced operations. The uppermost party devoted its efforts first to the protection of Hickory Island, 157 miles above Pittsburg, and on October 31 had removed 1,200 cubic yards of bowlders from the channel in that vicinity and deposited them along the channel face of the island, making a covering 2 feet thick, extending from low water to the plane of a 14-foot stage for the distance of 600 feet. The party then moved up

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to White Oak Chute, a very dangerous point 3 miles above Hickory, and removed 288 cubic yards of bowlders from the channel. The second or middle party began its work at Tionesta, 152 miles above Pittsburg, and continued down to Red Bank, covering a distance of 88 miles. It removed 375 cubic yards of bowlders, 17 snags, and 22 cubic yards of gravel. It also repaired the right abutment of the dam at Tionesta, replacing some stone filling which had washed out, and adding some heavy bowlders to the bottom protection of both abutments. The lower party started at East Brady, 70 miles above Pittsburg, and continued its operations down to Murphys Island, a distance of about 36 miles, removing 1,136 cubic yards of bowlders and 28 snags. This party also placed 118 cubic yards of bowlders around the undermined portion of the head of the upper dike at Cowanshannock. The bowlders removed from the channel were generally conveyed to the bank or placed in remote chutes to prevent the waste of water through them. Owing to the exhaustion of the appropriation these operations were suspended on November 15.

From late examinations and reports it appears that the Corydon log chute and the dams and dikes at Cornplanter, Hickory, Tionesta, Pithole, Six Mile Island, and the lower dike at Cowanshannock are in good condition, but that the upper Cowanshannock Dike has again undermined around its head. The abandoned dam at Nicholson's has not changed materially during the year.

The old portion of the Red Bank Dike was undermined during a freshet, at a few hundred feet above its junction with the new part; a breach in the dike followed, which has been enlarged by successive river rises to 220 feet width and average low-water depth of 4 feet. During the coming fall effort will be made to prevent further damage until next year, when funds may be available for proper repair.

Money statement.

July 1, 1897, balance unexpended	$11,766.13
June 30, 1898, amount expended during fiscal year	11,186.00
July 1, 1898, balance unexpended	580.13
July 1, 1898, outstanding liabilities	3.20
July 1, 1898, balance available	576.93
Amount that can be profitably expended in fiscal year ending June 30, 1900 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	25,000.00

NOTE.—Three thousand dollars allotted from improving Allegheny River for survey of Allegheny River.

Appropriations.

March 3, 1879	$10,000	September 19, 1890	$20,000
June 14, 1880	20,000	July 13, 1892	25,000
March 3, 1881	25,000	August 18, 1894	12,500
August 2, 1882	15,000	June 3, 1896	12,500
July 5, 1884	35,000		
August 5, 1886	30,000	Total	230,000
August 11, 1888	25,000		

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COMMERCIAL STATISTICS.

[Compiled at United States Engineer Office, Pittsburg, for fiscal year 1897.]

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Barges	6,156	Palings	51
Bark	4,200	Piles	4,113
Bottoms, coal-boat	32,436	Poles, brace	3,000
Cattle	248	Posts, check	1,700
Coal	7,003	Posts, pit	5,717
Freight, general	3,600	Sand	110,225
Grain	360	Sheep	179
Gravel	29,253	Shingles	400
Hay	1,092	Staves	1,500
Hogs	136	Stone	18,579
Horses	315	Ties, railroad	875
Lath	500	Timber	104,013
Lumber	92,692		
Manure	8,325	Total	436,668

Passengers carried, 18,208.

The river trade above Pittsburg consists of rafting, running downstream of new barges and boat bottoms with loads of lumber, hay, or tan bark, and movement of flat loads of sand and gravel.

Upon the abolition of tolls at the Monongahela River locks the two Allegheny River packets were transferred to the Monongahela and have not been replaced on the Allegheny, so that for applying the above table to the fiscal year 1898 the steam boat items of cattle, general freight, grain, live stock, and passengers should be omitted.

It is not likely that packets will run on the Allegheny above Pittsburg until the river improvement is more satisfactory or the numerous low bridges be raised.

Allegheny River distances, Pittsburg to Oil City.

[From river survey, 1896–97.]

Place.	Distance.	Place.	Distance.
Union Bridge, at the Point, Pittsburg	0.0	Kittanning Bridge	45.6
Sixth Street Bridge	.55	Lower Cowanshannock dike	48.7
Seventh Street Bridge	.65	Upper Cowanshannock dike	49.1
Ninth Street Bridge	.75	Mosgrove	51.2
Fort Wayne Railroad Bridge	.97	Templeton	55.5
Sixteenth Street Bridge	1.34	Mahoning	56.2
Herr Island lock, Twenty-first street	1.66	Rimerton	61.0
Thirtieth Street Bridge	2.35	Riverview	62.1
Pittsburg Junction Railroad Bridge	2.65	Red Bank dike	64.5
Forty-third Street Bridge (Millvale)	3.45	Red Bank Creek	64.9
Butler Street Bridge (Sharpsburg and Etna)	5.39	Red Bank Junction	65.0
		Phillipston	67.6
Six Mile Island lock (No. 2), and wing dam	7.00	East Brady	70.7
		Catfish Run	73.5
Aspinwall	7.37	Lower Hillville	76.4
Shades Run (Pittsburg city line)	8.34	Monterey	80.5
Verona	11.19	Parker Bridge	85.0
Pittsburg, Bessemer and Lake Erie Railroad Bridge	14.00	Clarion River	86.1
		Foxburg Bridge	87.8
Lock No. 3 (Springdale)	16.49	Emlenton Bridge	91.6
New Kensington	19.3	Dotter	94.7
Tarentum (Bull Creek)	21.6	Rockland	101.4
Natrona	24.2	Kennerdell	110.0
Freeport Bridge	28.7	Brandon	115.9
West Penn Railroad Bridge	30.0	East Sandy	120.9
Kiskiminetas River	30.2	Blue Rock Bridge	125.1
Clinton	35.7	Franklin Bridge	126.4
Kelly	36.2	Reno	130.7
Nicholson's dam	37.8	Oil City Suspension Bridge	134.0
Logansport	38.2	Oil City Relief Bridge	134.1
Roseton	40.7	Oil City and Petroleum Bridge	134.2
Ford City	42.0	Allegheny Valley Railway Bridge	134.7
Manorville	43.7		

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Bridges over Allegheny River between Pittsburg, Pa., and Olean, N. Y.

Name.	Distance above mouth.	Kind.	Superstructure.	Total length.	No. of spans.	Channel span between centers of piers.	Height above pool, or low-water level.	When built.
	Miles.			*Feet.*		*Feet.*	*Feet.*	
Union	.....	Highway.	Wooden trussed arch (Burr).	1,060	5	212	35.1	.....
Sixth street	0.5	.....do	Iron bowstring truss ...	1,036	2	445	33	*a* 1893
North side (Seventh street).	.6	.....do	Stiffened suspension iron bars.	1,080	4	330	34.6	1884
Ninth street	.7	.....do	Sub-Pratt truss	1,044	5	209	34	*a* 1892
Pittsburg, Fort Wayne and Chicago R. R.	.9	Railway ..	Iron lattice truss	1,167	9	152	35.3	.....
Sixteenth street	1.3	Highway.	Wooden trussed arch (Burr).	840	4	210	33	.....
Thirtieth street	2.4	.....do	Iron truss, continuous girder.	760	3	302	30.5	.....
Pittsburg Junction R. R. (Thirty-third street).	2.65	Railway ..	Open iron truss	841.4	4	{210.3 / 250}	34	1884
Forty-third street	3.4	Highway.	Wooden trussed arch (Burr).	980	4	244	30.3	.....
Sharpsburg (Butler street).	5.3	.....do	Open iron truss	905	5	181	31.7	.....
Freeport *b*	28	.....do	Iron bowstring truss ...	902.5	3	302.5	45	1896
Freeport (West Pennsylvania R. R.).	29.6	Railway ..	Open iron truss	795	5	185	47.3	*a* 1887
Kittanning	44.9	Highway.	Iron bowstring girder ..	900	5	180	32.7	.....
Bradys Bend	69.5	.....do	Open iron truss	750	4	200	36.2	*a* 1885
Parker	83.1	.....do	Iron bowspring girder..	790	4	197	34.5	*a* 1885
Foxburg	86	Railway and highway.	Wooden Howe truss, decked.	530.7	3	176.9	35.3	.....
Emlenton	89.6	Highway.	Open iron truss	456	2	228	36.6	*a* 1883
Big Rock	122	.....do	Wooden truss	700	4	175	27	1879
Franklin	123.1	.....do	Wood and iron truss ...	711	4	175	31.5	.....
Oil City	130.2	.....do	Suspension wire cable..	700	3	500	41	.....
Oil City (relief)	130.3	.....do	Iron truss	830	4	325	31.9	1893
Oil City	130.4	..... do	Open iron truss	1,100	6	200	36.6	*a* 1885
Allegheny Valley R. R.	130.6	Railway ..	Iron truss	450	3	150	29	*a* 1896
Tionesta	150.6	Highway.	Iron bowstring girder..	435	4	120	25.5	.....
Hickory	157.3	Railroad and highway.	Wooden Howe truss....	646	4	161.5	23.2	1883
Tidionte	165.3	Highway.	Suspension wire cable..	536	2	268	27.8	.....
Philadelphia and Erie R. R.	187.1	Railway ..	Iron truss	450	3	150	18.6	*a* 1896
Warren	187.7	Highway.	Suspension wire cable..	452	1	452	24.4	.....
Western New York and Pennsylvania R. R.	188.1	Railway ..	Iron truss	526	3	175	18	*a* 1889
Glade Run	189.9	Highway.	Wooden Howe truss....	568	4	142	20.2	1882
Great Bend (Western New York and Pennsylvania R. R.).	197.7	Railway ..	.....do	634	4	158.5	23.1	1882
Onoville	212.4	Highway.	Suspension wire cable..	505	7	82	13.1	1884
Quaker Bridge	218.2	.....do	Wooden queen truss....	300	4	75	17.5	.....
Red House	224	.....do	Open iron truss	375	3	125	18.1	*a* 1881
West Salamanca	230	.....do	Open iron truss, parabolic channel span.	643	4	154	17	.....
Western New York and Pennsylvania R. R.	231.1	Railway ..	Wooden Howe truss....	394	3	146	19.6	1883
Salamanca	231.8	Highway.	Iron parabolic truss	400	3	133½	15	1883
South Carrollton	237.8	Railroad and highway.	Wooden truss	280	6	84	17	*a* 1888
Tuna Creek	239.9	Highway.	Open iron truss	272	2	137	17	1885
Erie Railroad (Bradford Branch).	240.3	Railway ..	.....do	192	1	192	12.4	1883
Buffalo, Rochester and Pittsburg R. R.	240.3	.....do	.....do	203	1	203	14.1	1882
Allegany	250.6	Highway.	Iron bowstring girder..	400	4	100	19.4	.....
Western New York and Pennsylvania R. R.	251.3	Railway ..	Wooden Howe truss....	329	2	164.5	17.4	1882
Do	253.7	.....do	Wood and iron truss....	303	2	171	19.5	1885
Olean	255	Highway.	Iron truss	240	3	60	16.5	.....

a Rebuilt.

b Upstream from slackwater provided for.

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Bridges authorized and under construction at end of year.

Place.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of river.
				Clear width at intended pool or low-water level.	Clear height above intended pool or low-water level.	
	Miles.			*Feet.*	*Feet.*	
Denny	14.2	Iron truss, railway	4	500	51 to 55	Allegheny.
Mosgrove	51.2	Decked iron truss, railway	3	500	50	Do.

Place.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Denny	June 11, 1896	Aug. 18, 1896..	1 year from date of act....	3 years thereafter.
Mosgrove	.....	Feb. 23, 1898, amended plans May 24, 1898.	3 years from date of charter.	5 years thereafter.

Bridges authorized, but whose construction had not been commenced at end of year.

Place.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of river.
				Clear width at intended pool or low-water level.	Clear height above intended pool or low-water level.	
	Miles.			*Feet.*	*Feet.*	
New Kensington	19.2	Iron truss, highway	3	415	50	Allegheny.

Place.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
New Kensington	.....	Apr. 8, 1898	3 years from date of charter.	5 years thereafter.

NOTE.—Authority for bridge over Allegheny River at New Kensington, by the Tarentum Bridge Company, has expired by limitation.

Authority for bridge over Allegheny River at Creighton, by the Creighton Bridge Company, has expired by limitation.

Authority for bridge over Allegheny River below Tarentum, by the Kensington Rapid Transit Bridge Company, has expired by limitation.

G G 4.

CONSTRUCTION OF LOCKS AND DAMS AT HERR ISLAND, ABOVE THE HEAD OF SIX-MILE ISLAND, AND AT SPRINGDALE, ALLEGHENY RIVER.

Of these works the lock and fixed part of dam and accessory structures at Herr Island and lock at Springdale were under construction, the latter by contract. The contract was approved July 8, and includes the structures at Springdale and Six-Mile Island.

Lock and dam (No. 1) at Herr Island.—The project was modified so as to substitute a fixed masonry dam, pierced by three 4½-foot valve

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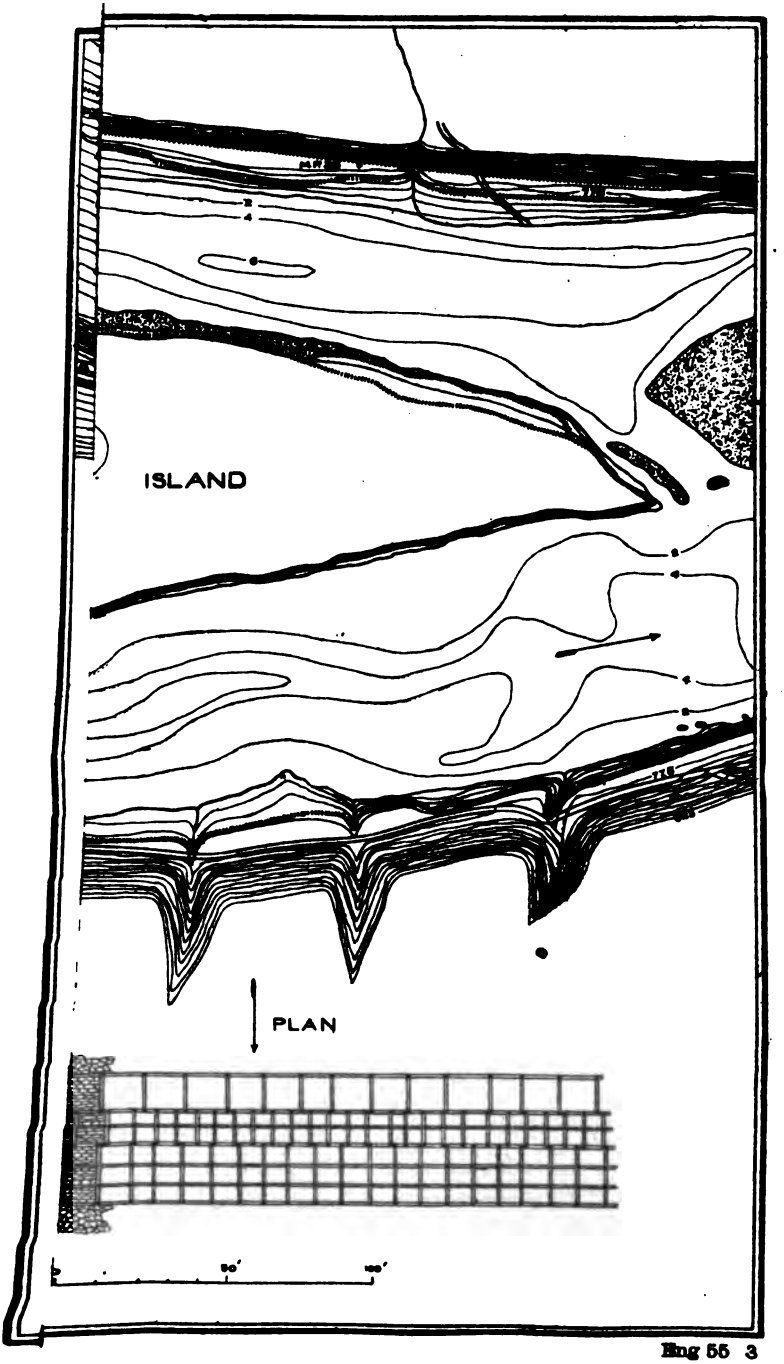

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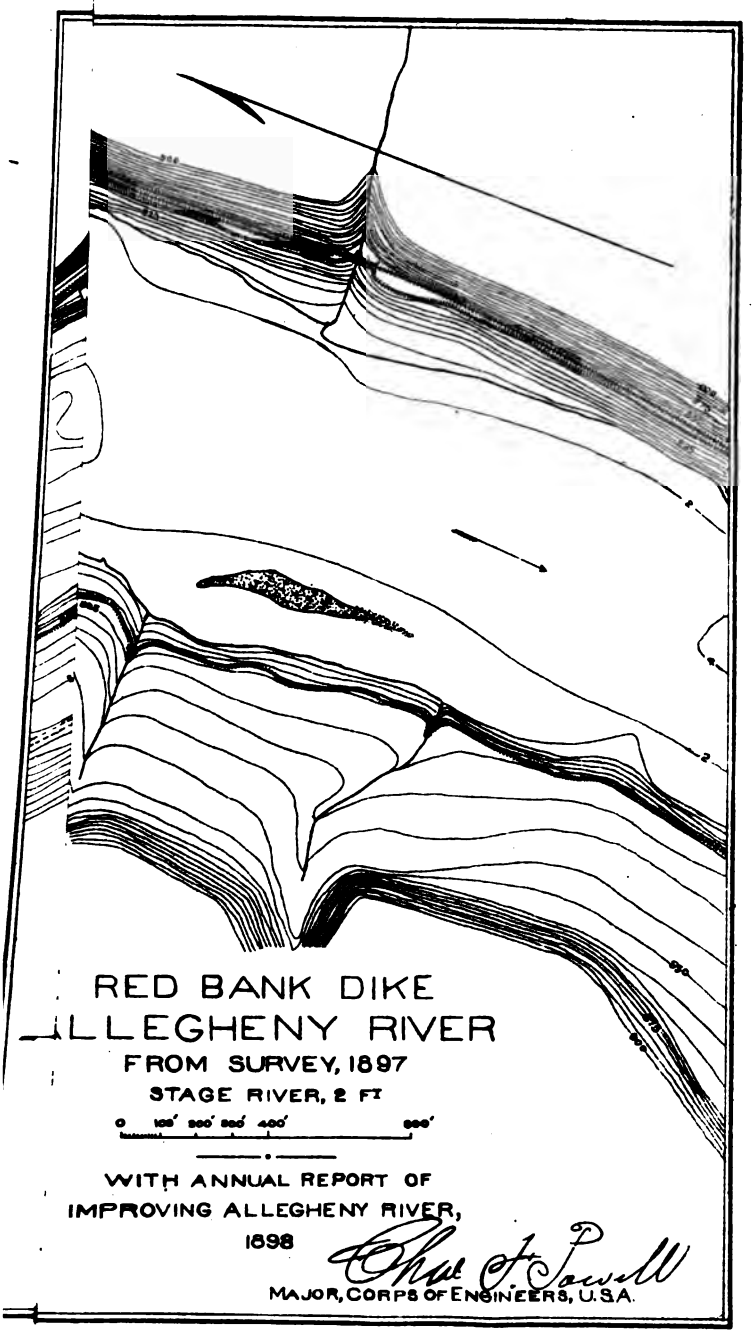

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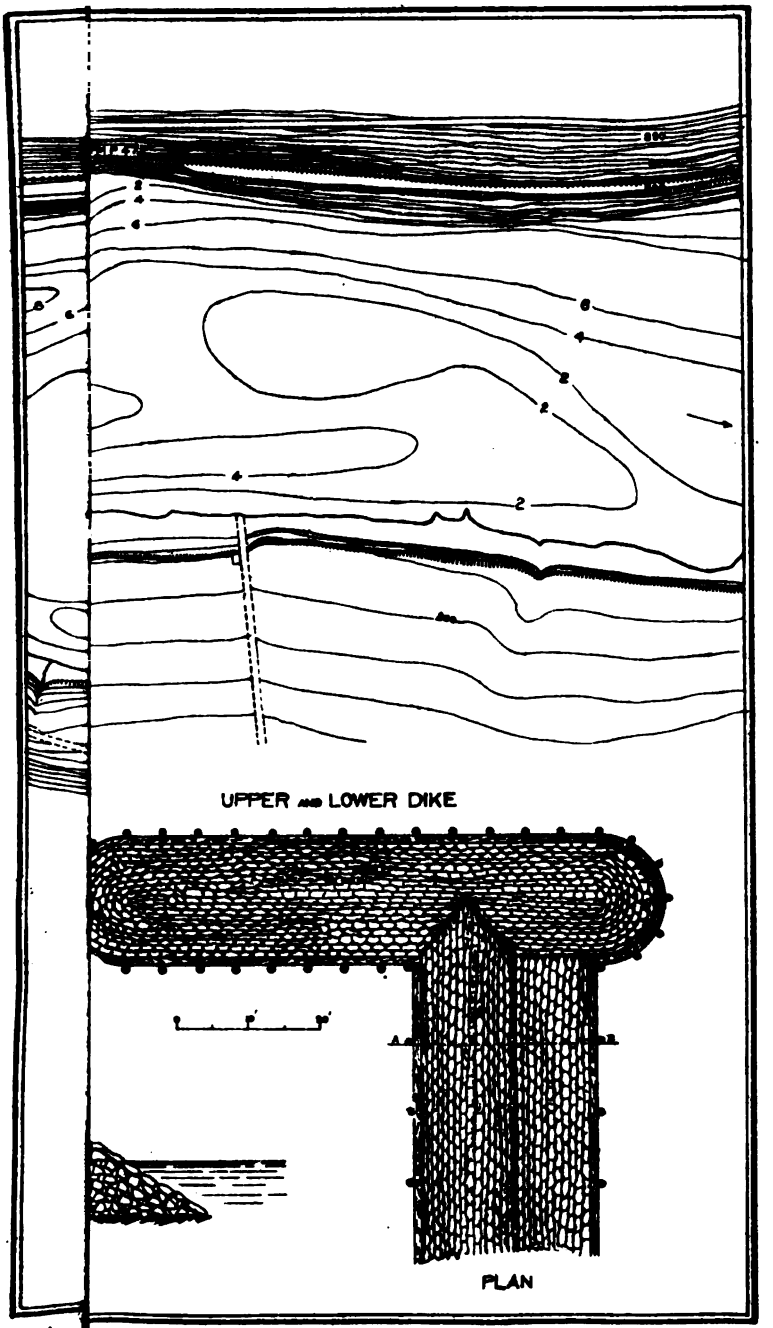

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culverts, for the Boulé dam, at the head of the navigable slip between the lock and adjacent bank. The plan of the main dam was modified to make the navigable pass 500 feet wide instead of 250 feet, to omit the trestle bridge and substitute two bear traps of 94 feet length each for the two Chanoine wicket weirs.

At the beginning of the year the lock-chamber walls, except a small block of masonry at each hollow quoin, had been built and the construction of the upper miter sill begun. During the year the lock masonry was completed; chamber floor and aprons under emptying culverts laid, and fixed dam and bulkhead masonry wall along harbor line at public property fronting the lock were built. Details of the operations with measurements of work and material from a report of Mr. J. W. Arras, assistant engineer, who has been connected with the construction during the year, are given below:

Sixteen anchor bolts for the gate cushions were set, the concrete foundation finished, and the stone miter sill, 2 feet in thickness, laid. The top of this sill is an elevation of 6 feet below the surface of the Davis Island dam pool, and of 13 feet below the level of the proposed pool above the lock. The small blocks of masonry over the pivot stones omitted in the construction of the lock walls, 7 feet by 10 feet, and running the full height of the walls and across the buttresses to a depth of 4 feet, were then constructed. This work was completed on July 22. Before moving the machinery from the upper end of the lock, the space between the upper miter and guard sills was excavated to a depth of 4 feet below the sill level and roughly paved with stone to a depth of 1 foot. While the pump and derrick were being erected at the lower end of the lock, the centers of the four flushing culverts around the gates were taken out, the culverts shaped with concrete to conform to the valve openings, and the concrete form removed from the interior faces of both lock walls and from the exterior face of the land wall. On July 29 the excavation for the foundation of the lower miter sill was commenced, and completed on August 4. The concrete foundation was then placed, 16 anchor bolts for the gate cushions and the stone miter sill set, and the quoin blocks of masonry omitted in the construction of the lock walls erected as at the upper sill. This sill, however, was constructed 2 feet lower in elevation than the upper sill, affording thereon a depth of 8 feet of water, measured from the level of the Davis Island pool, which is the controlling depth for navigation through this lock. This work was completed on August 21. The stone sills were then dressed for the reception of the hollow quoins, cast-iron gate pivots, and gate cushions, and the submerged sections of the quoins below the lower pool and the pivots and cushions set.

The lock floor, whose construction followed immediately, is built entirely of hemlock lumber. It consists of 10-inch by 16-inch girders 53 feet long, securely bolted to the vertical edges of the original form piles for the foundation of the lock, to which the flooring, 8 inches thick, is fastened with ⅞-inch driftbolts. The piles have a penetration of 26 feet; the girders are spaced 10 feet, and 1-inch spaces are left between the flooring to prevent the accumulation of a dangerous head underneath. It gives a depth of 10 feet under the lower pool. Its construction was started at the upper miter sill, and as it progressed the excavated material from the lock chamber was deposited on the finished part in order to overcome the buoyancy of the timbers until they had become thoroughly waterlogged. This work was finished on September 25, completing the lock below the level of the lower pool. During its progress the water was readily kept out of the lock chamber with one 4-inch centrifugal pump, maintaining a 22-foot head whenever desired. This indicates a very small amount of leakage through the foundation.

After moving all machinery from the lock, preparations were made for the erection of the fixed dam closing the passage between the lock and the left bank. It is located at the head of the lock and built normal to the lock axis. Its length is 104 feet, extending to the top of the bank; for a length of 70 feet the foundation is 18 feet thick, the bottom being 20 feet and the top 8 feet below the level of the Davis Island dam pool. The superstructure for a length of 70 feet is 14 feet thick at the base and 7 feet thick at the top, which is of the same elevation as the lock walls. The remainder of the dam is of a uniform thickness of 6 feet, extending down to the level of the upper miter sill of the lock, where a suitable foundation of compact gravel was encountered. The upper face of the dam is vertical. Three flushing culverts, each 4½ feet in diameter, passed through the dam within 50 feet of the lock, for the purpose of washing out light deposits forming in the 55-foot passageway required to be maintained for navigable purposes between the lock and bank by mutual arrangement between the United States and the riparian owners. The turbine waste also discharges through the dam. Along the upper face of the founda-

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tion there is a row of closely driven oak sheet piles 10 inches thick, extending to a depth of 30 feet below the surface of the lower pool, to check the leakage under the dam, and along its lower edge a crib work 55 feet long, 16 feet wide, and 8 feet deep, filled with stone and covered with heavy timber sheeting to prevent excessive scour at the exits of the flushing culverts. The dam, including its foundation, is built throughout of Portland cement concrete, and on its shore end a concrete stairway 6 feet wide rises to the top of the bank at the Government lot.

On October 20 active operations on this work were commenced by the erection of 2 cofferdams, one 89 feet long, closing the space between the head of the lock and the upper arm, and one 84 feet long, inclosing that between the foot of the lock and the lower arm of the original cofferdam. These were constructed largely from material recovered from the abandoned cofferdam around the lock. In building the upper section a depth of 18 feet of water was encountered, and a crib 15 feet square filled with stone and furnace slag was erected to support it. A 12-inch centrifugal pump, with a 14-inch by 18-inch engine to drive it, were installed at the head of the lock, and a steam line 500 feet in length laid to the boiler plant. On November 2 this work had been accomplished and the pump started, and on November 8 the inclosure was empty. The erection of the dam necessitated extensive undermining of the dilapidated pile trestle of the Pittsburg Junction Railroad, making it unsafe to operate its line over it, and the company moved its tracks temporarily back to the top of the bank. The excavation for the dam and crib work was quickly made, the latter built and the sheet piles driven. Since the dam would divide the inclosure in the cofferdam, it became necessary to install a second 12-inch pump to take care of the leakage below the dam. Two 4-inch pumps were also set where they could be utilized to the greatest advantage in equalizing the pressure on either side of the newly-laid concrete. During the latter part of November and in December several small rises occurred, delaying the work considerably. However, on December 9, the placing of concrete began and the foundation was completed during the month. Operations on the superstructure were continued at intervals of favorable weather and water conditions during the winter, being completed on March 18. In placing concrete in the excavation in the bank, the shoring was removed and the concrete carefully rammed against the sides of the pit to insure a perfect connection and prevent leakage around.

Following the completion of the fixed dam numerous spring freshets occurred, the highest, on March 24, reaching a stage of 31.4 feet above low water at the lock. Although this rise was mainly out of the Allegheny River, yet practically no damage was done to any of the works. The short intervals between these rises were taken advantage of and the concrete-mixing plant, derrick, and other machinery dismantled and removed from the site of the proposed retaining wall in front of the Government lot and other preparations made for the erection of the wall. The object of this wall is to permit of filling in and securing full use of the entire lot out to the line of the Pittsburg Junction Railroad for operating plant and residence for lock force, and at the same time to maintain the navigable depth of the 55-foot space inside of the land wall of the lock. Its length is 142 feet, extending from the fixed dam at the upper end to the lower side of Twenty-second street. The thickness at the base is 12 feet, top thickness 4 feet, and the height of the masonry 17 feet 4 inches, the top elevation being 2 feet higher than that of the lock walls. Its outer face has a batter of 1.4 inches per foot. The foundation consists of substantial oak piles driven to a penetration of from 16 to 18 feet, alternate piles of the outer row, which is spaced 1½ feet on centers, being driven to the inclination of the face of the wall. These are capped transversely with 12-inch by 12-inch oak beams, on which is laid a 20-inch floor in two courses of hemlock. The top of this timber floor is 3 feet 4 inches below the surface of the Davis Island pool and only 15 inches above extreme low water—a stage seldom reached—in order to insure its continual wetness. When the spring freshets had subsided, the excavation for the wall was made, the piles driven and floor laid, and the concrete placed to within 4½ feet of the final height, when a shortage of cement stopped the work. In the construction of the wall a small sewer, emptying at the mouth of Twenty-second street, was carried through it.

All of the surplus materials excavated from the foundations of the fixed dam and retaining wall were deposited back of the wall, raising the embankment almost to the level of the Government lot. To support this embankment along the line of Twenty-second street and the fixed dam under the Pittsburg Junction Railroad, retaining cribs were built of old piles and framing timber. Two timber bents were also erected in the trestle of the railroad to take the place of piles removed in constructing the dam.

Six apron cribs were constructed under the emptying culverts in the land wall of the lock to prevent scour. These are 6 feet by 18 feet by 4 feet 4 inches deep, filled with stone and covered with 4-inch oak planking. During the year the remains of about 850 feet linear of abandoned cofferdams and their attendant protection cribs were almost entirely removed.

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Summary of work performed and materials expended during the year.

Excavation and embankment:		
For miter walls	cubic yards	928
For lock floor	do	3,500
For fixed dam	do	1,940
For retaining walls	do	1,350
For cofferdam	do	1,550
		9,268
White oak timber:		
In lock	feet B. M	5,000
In fixed dam	do	8,450
In retaining wall	do	6,600
		20,050
Oak piles in foundation	linear feet	4,520
Hemlock lumber:		
In lock floor	feet B. M	162,234
In fixed dam	do	14,564
In retaining wall	do	32,200
In concrete forms	do	13,300
In cofferdams	do	24,000
		246,298
Hemlock piles in cribs	linear feet	2,700
Iron bolts and rods:		
In lock floor	pounds	12,042
In fixed dam	do	1,050
In retaining wall	do	3,000
In timber cribs	do	2,000
In cofferdams	do	5,500
		23,592
Valves and flanges, 4½ feet diameter	number	3
Gate pivots	do	4
Snubbing posts	do	4
Anchorage bolts	do	52
Stone:		
Dimension, in miter sills	cubic yards	107
Riprap, in crib work	do	600
Stone paving, in lock floor	square yards	127
Concrete laid, measurement in place:		
In miter walls	cubic yards	351
In lock walls	do	225
In fixed dam	do	1,093
In retaining wall	do	553
		2,222

It is expected to build at least one-half of the movable dam before the fall freshets occur, and erect the lock gates and place lock machinery by the time of the completion of the dam.

Lock and dam (No. 2) at Six-Mile Island.—The selected lock land here is a narrow strip of unimproved and unused river bank, belonging to the city of Pittsburg, whose officials insist upon a purchase price of about $15,000. Encouragement had been given that the land would be donated by the city, and the authority for acquiring title contemplates such donation.

Pending negotiations for the land, examinations have been made for another site. An apparently favorable one was found about two-thirds of a mile upstream from the original location. Borings made here, however, disclosed an absence of rock at any practicable depth for

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foundation, but showed some dangerous veins of quicksand in the river bed. Borings were also made downstream from the original location without finding a suitable site. Even at the original location the rock varies in depth between the lock walls from 6 to 46 feet below water surface, but considering all elements the location is the best one within the limited stretch of river where the lock must be put. It is hoped that the city will recede from its demands before the contractors are about ready to work at Lock No. 2.

Lock and dam (No. 3) at Springdale.—Agreement for purchase had been made for the lock land belonging to the Allegheny Valley Railroad Company, but difficulty occurring in obtaining satisfactory title on account of liens attached to bonded indebtedness, whose release could not be obtained, condemnation proceedings were instituted and concluded late last winter. As soon thereafter as river conditions reasonably permitted, the contractors shipped machinery and materials to the site, and on May 25 commenced active work. By the end of June the lock pit was partly excavated and a cofferdam nearly finished; a railroad side track, cement house, and other temporary structures erected, guide piles for building dam driven, and its trench partly dredged.

Money statement.

July 1, 1897, balance unexpended		$365,514.02
Amount appropriated by sundry civil act approved July 1, 1898		300,000.00
		665,514.02
June 30, 1898, amount expended during fiscal year		49,227.99
July 1, 1898, balance unexpended		616,286.03
July 1, 1898, outstanding liabilities	$15,130.95	
July 1, 1898, amount covered by uncompleted contracts	396,424.70	
		411,555.65
July 1, 1898, balance available		204,730.38
Amount (estimated) required for completion of existing project		244,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations.

August 5, 1886	$37,500
August 11, 1888	35,000
September 19, 1890	35,000
July 13, 1892	40,000
August 18, 1894	40,000
June 3, 1896	50,000
June 4, 1897	350,000
July 1, 1898	300,000
Total	887,500

Contract in force during fiscal year ending June 30, 1898.

No.	Name of contractor.	For.	Date of—		
			Approval.	Beginning work.	Expiration.
1	Sloan, McIlvain & Ott Bros., Allegheny, Pa.	Locks and Dams Nos. 2 and 3, on Allegheny River.	July 8, 1897	May 25, 1898	Three years from acquirement of necessary lands.

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COMMERCIAL STATISTICS.

[Compiled at United States Engineer Office, Pittsburg, for 1897.]

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Cars, empty	86,700	Piles	180
Cars, loaded	605,990	Sand	167,873
Coal	405,119	Staves	690
Freight, general	2,580	Stone	6,400
Gravel	286,468	Ties, Railroad	86,263
Lumber	36,000		
Manure	16,790	Total	1,701,053

Passengers carried, 9,685.

The above table refers to the Allegheny River traffic at and near Pittsburg. For statistics as to the traffic of the river above, and which will be benefited by the slack-water system provided for, see report upon improvement of Allegheny River.

G G 5.

SURVEY FOR REMOVAL OF DAM IN UPPER ALLEGHENY RIVER NEAR CORYDON, PA., AND OF ALL THE DAMS ON THE CONEWANGO CREEK, AND THE RAPIDS AT OR NEAR WATERBORO, IN THE CONEWANGO CREEK.

[Printed in House Doc. No. 110, Fifty-fifth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 2, 1897.

SIR: I have the honor to submit the accompanying copy of a report, dated November 13, 1897, with map, by Maj. Chas. F. Powell, Corps of Engineers, upon a survey for the removal of dam in the Upper Allegheny River near Corydon, Pa., and of all the dams on the Conewango Creek and the rapids at or near Waterboro, in the Conewango Creek, a tributary of the Allegheny River, made to comply with the provisions of the river and harbor act of June 3, 1896.

Corydon Dam.—Major Powell states that since the construction by the Government in 1888 of crib work along the lower slope of this structure there has been no special trouble experienced by raftsmen in running the dam; but below the dam there is a gravel bar extending more than halfway across the chute, which makes the channel tortuous and inconvenient for rafts, and that it is expected to make a needful excavation here next year should the appropriation for improving the river be sufficient to permit work so far upstream. The cost of removing the dam to a depth of 4 feet from low-water level below the dam is estimated at $897.50.

Dams on the Conewango Creek.—The cost of removing all these dams (four in number) is estimated at $2,400, exclusive of damages for destroying or diminishing water powers.

Waterboro Rapids.—It is stated in the report that there is no navigation on Conewango Creek other than some little logging, and that none other is in prospect. The cost of making a cut-off from the head of these rapids is estimated at $11,500, exclusive of costs for land and drainage; of removing the upper part of the rapids by excavation from their head along the creek to the pool of the Kennedy Dam, $22,500;

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and of removing the whole of the rapids by similar excavation, $90,000, exclusive of damages to the Kennedy water power. The effect of either of such works would be to lower the water levels above the rapids and raise them below the end of the cut-off or excavations, and generally to disturb the present small conservation of the flow of the creek.

In the opinion of Major Powell the removal of the Corydon Dam at the present time and of the dams or of the rapids at or near Waterboro, in Conewango Creek, is a work not worthy nor justified by the interests of commerce involved.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. CHAS. F. POWELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., November 13, 1897.

GENERAL: I have the honor to submit the following report upon the survey for removal of dam in Upper Allegheny River near Corydon, and all the dams on the Conewango Creek, and the rapids at or near Waterboro, in the Conewango Creek, a tributary of the Allegheny River:

Corydon Dam.—This structure lies across the main or west chute made by a small island in the Allegheny River at Corydon, Pa., about 1 mile south of the New York State line, and 209 miles above the mouth of the river.

The dam has a lift of 3½ feet at low water and is 377 feet long. It was built about seventy years ago to develop water power and is still so used. Below the dam there is a fall in the slope of the chute of about 3 feet to the lower end of the island, near which and across the smaller chute the mills are located. There were formerly four mills; one of them has been abandoned. These mills are now operated, one, Morrison's, has two 25-horsepower turbines, set for a 6-foot head, and two scroll wheels of 10 horsepower each, which run one butting, one edging, and one mill saw; Whitcomb & Marsh Bros.' shingle mill has a shingle saw and a butting saw, run by a scroll wheel; Whitcomb & Marsh Bros.' grist, planing, and spoke mill has two 25 horsepower turbines under a 6-foot head, which operate 6 saws, 3 run of stone, a flour bolter, a fanning mill, a cornsheller, and a spoke lathe.

The dam is built of three rows of piles and of riprap stone. It is sheeted on top, There is also inclined sheeting on the upper face, backed by stone. The lower face of the original dam was vertical. At low stages, after rafting on the river has ceased, the mill men place low flashboards on the dam to impound the water for preserving the head.

There has been no steamboating on or near this part of the Allegheny River, but there was considerable rafting of lumber and logs, which is still continued, but in a gradually diminishing extent, principally on account of decrease of supply of timber and increase of railroad transportation of lumber northward and eastward; that is, in upstream directions, as well as down the Allegheny Valley.

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At ordinary rafting stages the dam was formerly a dangerous obstruction. In 1888 the Government built crib work along the lower slope of the dam, whereby its vertical face was replaced by a gently inclined slope, having an average slope of 1 foot in 6 feet. The crib work is ballasted. Its top is paved and sheeted. The lower face of the crib work is vertical and its top is at the surface of low water.

Since the addition of the crib work there has been no special trouble in running the dam, and raftsmen expressed themselves as being satisfied with the work and its results. Inquiry as to present opinion has not shown that the removal of the dam is called for by raftsmen or other river men or lumber shippers. Below the dam, and probably aggravated by it, is a gravel bar extending more than halfway across the chute, which makes the channel tortuous and inconvenient for rafts. A few years ago the channel was bettered by excavating the end of the bar. The work needs to be repeated from time to time, and it is expected to make needful excavation here next year if the appropriation for improving the Allegheny River is sufficient to permit work so far upstream.

In 1896 Mr. Barnard Salisbury, fish and game protector, Thirtieth New York district, wrote:

> To these [pleasure boats and fishing and hunting parties] the Corydon Dam is a standing menace. But the greatest evil of this dam is the perfect barrier it presents to the upward migration of the various finny tribes to the head waters and tributary streams of the Allegheny River. All the people of Cattaraugus County and border counties of Pennsylvania who are in any way interested in piscatorial matters are deeply interested in the removal of the Corydon Dam or the construction there of an adequate fishway.

The estimated cost of removing the dam to a depth of 4 feet, from low-water level below the dam is:

Removal of 2,000 cubic yards of stone, at 25 cents	$500.00
Removal of 150 piles, at $1.25	187.50
Removal of 105,000 feet B. M. of crib work and sheeting, at $2	210.00
Total	897.50

In my opinion the removal of the Corydon Dam at the present time is not worthy and not justified by the interests of commerce involved.

Dams on the Conewango Creek.—This stream rises in western New York, east of Lake Chautauqua, flows southerly, and empties into the Allegheny River at Warren, Pa., 14 miles below the State line and 188 miles above the mouth of the river. The outlet of Lake Chautauqua enters Cassadaga Creek, the main branch of the Conewango, which it joins about 14 miles upstream from the State line.

The dams on the Conewango Creek are: Warren Dam, located within the corporate limits of Warren; North Warren Dam, 3 miles above the mouth of the creek; Russell Dam, 7.5 miles above the mouth, and Kennedy Dam, 1 mile above the town of Kennedy, N. Y., and about 38 miles above the mouth of the creek.

Warren Dam was first built in 1810 and was rebuilt in 1869. It is a timber structure resting on a pile foundation, about 550 feet long, and has 3.6-foot lift. The dam furnishes power under a 5-foot head to Newmaker & Reed's saw and planing mill, the Warren flour and grist mill, and the Hazeltine proprietary medicine works.

North Warren Dam is 200 feet long and has a lift of 2.5 feet. It supplies power under an 8-foot head to a woolen mill, 1½ miles below, which was rebuilt in 1895 at an expense stated to have been over $20,000.

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The mill is operated by the Hazeltine Woolen Mills Company, of Warren, Pa. The dam was built about 1812 and rebuilt in 1845.

Russell Dam is 200 feet long and has a 2.5-foot lift. It is of timber, and was built in 1809 and has since been maintained by repairs. The dam furnishes power to Thompson's saw and planing mill and Lane's gristmill. Both mills are equipped with modern machinery. They are a half mile below the dam and have a 7-foot head.

Kennedy Dam is 1 mile above the town of Kennedy, N. Y., and about the same distance below the head of the Waterboro Rapids. It is 116 feet long, has a 3-foot lift, and supplies power to Nichols's saw and planing, cider, and grist mills and Thomas's flouring mill, about 1.5 miles below the dam, where a head of 11 feet is afforded. The dam is well constructed of timber, ballasted with stone, and sheathed with plank. It was built in 1805, and has been renewed or repaired from time to time and kept in good condition. The dam has a log chute 27 feet wide. Such feature was formerly a part of all the dams.

The cost of removing all the dams is estimated to be $2,400, exclusive of damages for destroying or diminishing water powers.

Waterboro Rapids, Conewango Creek.—The head of these rapids is 39.5 miles above the mouth of the creek and 2.5 miles upstream from Kennedy, N. Y. The rapids are about 4 miles long. The total fall over them is 24 feet. The slope is tolerably uniform over the whole ripple, except, of course, at the Kennedy Dam and its pool.

The upper part of the rapids lies in a sharp bend, as shown by the accompanying sketch. At the head of the rapids the low-water width is 19 feet and greatest depth 2 feet. The pool above the rapids, which extends for several miles, has an average low-water depth of 10 feet and width of 100 feet. Its banks are low and marshy.

In 1874 a cut-off across the neck in its head was commenced by the Buffalo and Southwestern Railroad Company for the purpose of avoiding the necessity of building two bridges across the creek. The project was antagonized by the New York, Pennsylvania and Ohio Railroad Company, probably because the cut-off would jeopardize the safety of its bridge across the creek and adjacent roadbed. The cut-off work was stopped by a perpetual injunction.

The lines of the cut-off and railroads are shown upon the sketch. The land between the two railroad beds is about 6 feet above low water of the creek. A few small areas of the neck are cultivated. The abandoned cut-off is now almost filled, but is still plainly marked.

It also appears that in recent years two bills providing for improved drainage of this part of Conewango Creek have been introduced in the New York legislature, but failed of passage.

The estimated costs of making the projected cut-off of 1874 is $11,500, exclusive of cost of land and of drainage to the New York, Pennsylvania and Ohio Railroad, now the Erie Railroad Company; of removing the upper part of the Waterboro Rapids by excavation from their head along the creek to the pool of the Kennedy Dam is $22,500, and of removing the whole rapids by similar excavation is $90,000, not counting damages to the Kennedy water power. The effect of either of such works would be to lower the water levels above the rapids and raise them below the end of the cut-off or excavations, and generally to disturb the present small conservation of the flow of the creek.

The course of Conewango is tortuous; its banks are low. Much of the adjacent land is waste, due to frequent inundations and insufficient drainage. It contains many islands, which are small and low. The aver-

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age width of the stream below the head of the pool above the Conewango Rapids is about 100 feet, and about 50 feet in the island chutes. From the rapids to the mouth of the stream there are 17 bridges, from 10 to 18 feet above low water.

There is no navigation on the creek other than some little logging, and none is in prospect.

In my opinion the purposed removal of the dams or of the rapids at or near Waterboro, in the Conewango Creek, is not worthy and not justified by the interests of commerce involved.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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APPENDIX H H.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE SUPERIOR.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Grand Marais, Minnesota.
2. Harbor at Agate Bay, Minnesota.
3. Harbor at Duluth, Minnesota, and Superior, Wisconsin.
4. Harbor at Ashland, Wisconsin.
5. Harbor at Ontonagon, Michigan.
6. Waterway from Keweenaw Bay to Lake Superior, Michigan.
7. Harbor at Marquette, Michigan.
8. Harbor of refuge, Marquette Bay, Michigan.
9. Harbor of refuge at Grand Marais, Michigan.
10. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 18, 1898.

GENERAL: In compliance with General Orders, No. 2, Headquarters, Corps of Engineers, United States Army, Washington, D. C., April 11, 1898, I have the honor to transmit herewith my annual report * * * of the works under my charge.

* * * * * * *

Very respectfully,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

H H 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

This harbor is an elliptical bay, whose major axis is about one-half mile and whose minor axis is about one-fourth of a mile in length. It has an opening on the south side, which was originally about 1,000 feet in width. Before improvement there was a maximum depth of 14 feet over a very limited area, the general average depth being only 8 or 9 feet. It is the only harbor of refuge on the north shore between Two Harbors (Agate Bay) and the international boundary line.

The approved project of 1879 is to build two breakwater piers, each 350 feet long, from the east and west points of the bay, or one pier 700

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feet long from the east point, and dredge an anchorage area of about 26 acres to a depth of at least 16 feet, all at an estimated cost of $139,669.40. The object of this work is to provide a harbor for purposes of refuge and commerce, which it has fully accomplished as far as completed.

The improvement of the harbor commenced in 1880. At the present time the length of completed breakwater is 350 feet, or one-half of the whole, and the 16-foot anchorage is 26 acres in extent. This completes this part of the project.

This anchorage gives room for safe swinging at anchor of a few vessels only and should be increased to the full capacity of the harbor, which has an area of about 61 acres. To protect this area properly would require a further extension of the pier some 500 feet, instead of 350 feet, as provided for in the present project.

The first commercial report, that of 1878, showed that 4 tugs and 5 schooners entered and departed from this harbor, making 25 arrivals and clearances in all, and doing a business of 60 tons, valued at $6,000. Last year, navigation season of 1897, the total arrivals and clearances were 371 vessels, principally steamers, with a total cargo tonnage of 1,777 tons, valued at $122,868.

Rich mineral deposits are alleged to exist in the back country. Should these be opened up and connected with the lake by railroad, the harbor may become of some importance for the shipment of ore.

The work of improvement has been carried on by contract after due advertisement. The total amount dredged to date has been 337,948 cubic yards, at an actual cost of $81,463.50, or a trifle more than 24 cents a cubic yard as an average.

The 350 feet of pier has cost $31,147 for construction and $3,205 for repairs. These figures do not include expenses of surveys, administration, and inspection, which have been nearly 15 per cent, owing to the distance of this harbor from the market for labor and material and its isolated situation in general.

Of the original estimated cost of the present approved project, $133,350 has been appropriated, requiring $6,319.40 to complete the estimate. This estimate, made back in 1879, will be insufficient to complete, due to an underestimate as to cost of piers and an overexpenditure for dredging. The dredged area has been carried out to give a navigable depth of 16 feet, whereas the estimate was originally intended for only 14 feet, although it does not so state specifically. (See Report of Chief of Engineers, 1875, p. 184.)

The project, as far as dredging is concerned, is completed. To complete the original project, there remains to construct 350 feet of breakwater, either as a separate structure at the westerly side of the entrance, or as a continuation of the present breakwater on the easterly side. It is probable that the building of the westerly breakwater will be more desirable than an extension of the easterly one. For this I estimate 350 feet at $80, including the necessary embankment, $28,000. For inspection, administration, etc., $2,604.63; total, $30,604.63. The total estimate for the work, therefore, as thus increased would be $163,954.63 (see letter, Chief of Engineers, August 16, 1898*), of which $133,350 has been appropriated.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

* Not printed.

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Money statement.

July 1, 1897, balance unexpended	$728.23
June 30, 1898, amount expended during fiscal year	123.60
July 1, 1898, balance unexpended	604.63
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations for improving harbor at Grand Marais, Minn.

By act of Congress—		By act of Congress—	
Approved March 1, 1879	$10,000	Approved September 19, 1890	$22,350
Approved June 14, 1880	10,000	Approved July 13, 1892	10,000
Approved March 3, 1881	20,000	Of August 18, 1894	3,000
Passed August 2, 1882	20,000	June 3, 1896	3,000
Approved July 5, 1884	10,000	Total	133,350
Approved August 5, 1886	10,000		
Passed August 11, 1888	15,000		

Expenditures.

Amount expended under approved project to June 30, 1898	$132,745.37
Balance available July 1, 1898	604.63

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Minn., for 1897.

Designation.	Arrivals.	Clearances.	Total.
Coastwise	126	123	249
Foreign	59	63	122
Total	185	186	371

Freight received and shipped, 1897.

Receipts:		
Grain	tons	90
Flour	do	55
Mill stuff	do	69
Coal	do	89
Manufactured iron	do	7
Hay	do	117
Miscellaneous merchandise	do	1,117
Lumber	do	175
Total	do	1,719
Shipments:		
General merchandise	do	25
Fish	do	33
Total	do	58
Passengers:		
Arriving		200
Departing		200
Total		400

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Freight received and shipped for sixteen years.

Year.	Tons.	Value.	Year.	Tons.	Value.
1882	224	$25,691	1890	275	$32,035
1883	239	27,595	1891	319	32,687
1884	270	30,198	1892	756	65,374
1885	390	41,484	1893	907	78,460
1886	475	48,519	1894	441	41,230
1887	312	29,059	1895	913	91,300
1888	460	44,871	1896	1,360	114,198
1889	252	29,349	1897	1,777	122,868

No new lines of transportation were established.

Arrivals and clearances of vessels for sixteen years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1882	134	134	1890	268	268
1883	131	131	1891	160	159
1884	152	158	1892	146	145
1885	188	190	1893	133	133
1886	210	210	1894	219	221
1887	164	164	1895	186	181
1888	190	190	1896	202	200
1889	168	168	1897	185	186

H H 2.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

Agate Bay, on which is situated the town of Two Harbors, Minn., is a semicircular harbor of 2,000 feet radius. There is a good navigable depth throughout the greater part of the harbor, but it is exposed to storms from the southwest and from reverse swells of hard storms from the northeast.

The natural shelter it afforded justified the erection of three extensive ore docks by the Duluth and Iron Range Railroad, also a good commercial dock and a dock for landing coal.

The rapid increase in the commerce of the harbor caused Congress to undertake its improvement by an appropriation of $22,500 in August, 1886.

The approved project of 1887 was to construct two breakwater piers on a line toward each other from the eastern and western points of the bay, to be 1,000 and 900 feet long, respectively, leaving an opening of 1,340 feet between their extremities and inclosing an area of 109 acres.

The amount expended on this project up to the close of the fiscal year ending June 30, 1897, was $120,999.70. At that date the work done had greatly aided commerce by giving protection from storms to the commercial and ore docks. The work done during the fiscal year ending June 30, 1898, has augmented this protection.

The original estimate of cost was $213,000, which was increased to $244,208 in Annual Report of 1887 on account of higher prices.

The object is to protect shipping at the wharves, which otherwise would be greatly exposed. Work was commenced in 1887 on the east pier, which is now 750 feet in length, leaving 250 feet to be built to complete. Of the west pier, 550 linear feet have been completed, and in addition 410 linear feet of rock embankment brought up to the —20-foot level, low-water datum. This last part was completed Septem-

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ber 30, 1897, under the contract with Porter Brothers. On January 31, 1898, after due advertisement, a contract was made with King & Steele to build 300 linear feet of crib foundation and superstructure in extension of the west pier, to be founded on the embankment already in place. This contract is now in force. One crib is ready for sinking, and two more have been partially completed. With the execution of this contract the available funds will be exhausted.

There is not yet perfect security from southwest storms for vessels lying at the merchandise dock, but it is no longer necessary to leave the harbor and seek security elsewhere. The favorable results already obtained with the portions of the breakwater now built are much greater than anticipated, and emphasize the advisability of speedily completing the remainder of the projected piers.

The Duluth and Iron Range Railroad has now in successful operation five large ore docks.

Of iron ore alone there was shipped from this port during the season of 1897 2,651,273 gross tons.

The total amount expended on this harbor from 1886 to June 30, 1898, has been $155,389.54. During this period of twelve years the annual cargo tonnage has increased from 236,000 tons, valued at $524,800, in 1885, to 2,730,322 tons, valued at $4,000,000, in 1897. The total valuation of the cargo tonnage into and out of this port in the twelve years ending December 31, 1897, is roughly estimated at $24,500,000.

Mr. John Krey, assistant engineer, continues in local charge.

Agate Bay, known locally as Two Harbors, is in the collection district of Duluth, Minn., which is also the nearest port of entry. The nearest light-house is situated on the east point, Agate Bay, Minnesota.

Money statement.

July 1, 1897, balance unexpended	$51,500.30
June 30, 1898, amount expended during fiscal year	34,389.84
July 1, 1898, balance unexpended	17,110.46
July 1, 1898, amount covered by uncompleted contracts	15,300.00
July 1, 1898, balance available	1,810.46
Amount (estimated) required for completion of existing project	71,708.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	71,708.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Abstract of appropriations for improving harbor at Agate Bay, Minnesota.

By act of Congress—	
Approved August 5, 1886	$22,500
Passed August 11, 1888	15,000
Approved September 19, 1890	25,000
Approved July 13, 1892	30,000
Of August 18, 1894	30,000
Passed June 3, 1896	50,000
Total	172,500

Estimates.

Amount necessary to complete the present approved project as based on the last estimate of 1887	$71,708
Amount required annually for preserving and maintaining the improvement after completion	2,000

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Abstract of proposals received in response to advertisement for building 300 feet, more or less, of timber crib and superstructure for west breakwater at Agate Bay (Two Harbors), Minn., opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, January 20, 1898.

No.	Name and address of bidder.	300 running feet (more or less).		Total.
		For cribs and stone filling and underfilling and riprap in place, 18½ by 24 feet (per running foot).	For superstructure, including stone filling (per running foot).	
1	Norris & Fitzgerald, Duluth, Minn	$45.75	$16.75	$18,150
2	King & Steele, Duluth, Minn	37.20	13.80	15,300
3	Lipsett & Gregg, Sault Ste. Marie, Mich	39.00	14.50	16,050
4	Frederick Davis, Duluth, Minn	43.90	12.00	16,470
5	Porter Bros., Duluth, Minn	39.20	14.00	15,960

LIST OF EXISTING CONTRACTS.

Contract for building 300 feet, more or less, of timber crib and superstructure for west breakwater at Agate Bay (Two Harbors), Minn., with King & Steele, of Duluth, Minn., dated January 31, 1898, approved March 7, 1898. Work commenced April 15, 1898, and to be completed by November 1, 1898.

COMMERCIAL STATISTICS.

Vessels arriving and departing at Agate Bay, Minnesota.

Year.	Vessels.	Estimated tonnage.	Increase.
1885	174	295,800	
1886	263	460,000	164,200
1887	465	697,500	237,500
1888	749	1,436,000	738,500
1889	1,255	2,400,000	964,000
1890:			
Steam, 968 Sail, 82	1,050	2,625,000	225,000
1891:			
Steam, 1,188 Sail and whaleback, 62	1,250	2,915,000	290,000
1892:			
Steam, 1,104 Sail, 186 Whaleback, 40	1,330	3,101,600	186,600
1893:			
Steam, 1,016 Sail, 146 Whaleback, 16	1,178	2,386,200	—715,400
1894:			
Steam, 1,432 Sail, 116 Whaleback, 70	1,618	3,236,000	849,800
1895:			
Steam, 1,748 Sail, 850 Whaleback, 896	2,494	4,900,000	1,664,000
1896:			
Steam, 1,444 Sail, 316 Whaleback, 228	1,982	4,360,000	—540,000
1897:			
Steam, 1,428 Sail, 334 Whaleback, 302	2,064	6,192,000	1,832,000

Value of freight received and shipped, exclusive of iron ore, $323,000.

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Receipts and shipments.

Year.	Ore shipped.	Other freight received and shipped.	Total.
	Tons.	*Tons.*	*Tons.*
1885	225,484	10,895	236,379
1886	304,396	21,954	326,350
1887	394,252	6,620	400,872
1888	509,964	30,352	540,316
1889	924,054	31,731	955,785
1890	984,215	37,268	1,021,483
1891	1,000,052	41,181	1,041,233
1892	1,304,885	54,477	1,359,362
1893	902,268	57,616	959,884
1894	1,373,117	66,053	1,439,170
1895	2,139,526	79,004	2,218,530
1896	1,814,186	91,373	1,905,559
1897	2,651,273	79,049	2,730,322

Estimated value of freight received and shipped (exclusive of ore).

Year.	Amount.	Year.	Amount.
1887	$96,000	1893	$360,000
1888	212,000	1894	300,000
1889	222,000	1895	220,000
1890	246,000	1896	378,000
1891	225,000	1897	323,000
1892	320,000		

There were no new lines of transportation established last year, but several new boats were added to the old lines.

H H 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA, AND SUPERIOR, WISCONSIN.

The act of June 3, 1896, unified these harbors under the above title and provided for continuous contracts for its improvement to the amount of $3,080,553.

This harbor consists now of the Duluth Canal, the Wisconsin Entrance, Superior Bay, Allouez Bay, St. Louis Bay, and St. Louis River to the limits of the cities of Duluth and Superior, about 20 miles from the original natural entry, which, before improvement, was obstructed by shifting bars, with but 9 feet of water over them. The bays were broad expanses of shallow water, averaging only 8 or 9 feet, except along the channel through them, where the depth was greater, but variable.

The previous project was practically completed July 1, 1897, and resulted in giving a good 16-foot navigation through the natural or Wisconsin Entry, through the artificial Duluth Canal, over the Duluth Basin of 104 acres, along and parallel to the dock lines of Duluth and Superior, in Superior and St. Louis bays, and up the St. Louis River to New Duluth, near the head of navigation of the river, with well defined channels from 85 to 300 feet in width.

The amount expended thereon up to the close of the fiscal year ending June 30, 1897, was $1,587,502.97. The improvement thus made is

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in excellent condition, and the expenditure has been amply justified by the immense commerce which it has readily accommodated. (See commercial statistics hereafter.)

The new project authorized by the act of June 3, 1896, provides for the widening and deepening to 20 feet of the existing channels, for a new 20-foot channel along Minnesota Point dock line, for new channels in Allouez Bay, for extensive turning and anchorage basins 20 feet deep at the junctions of two or more channels, for widening the Duluth Canal, and for replacing with substantial structures of timber and monolithic concrete the piers at the Duluth Canal and the Wisconsin Entrance.

The title to the land covered by the present Duluth Canal, and that necessary for its enlargement, has now been acquired by deed of gift, by purchase directly from owners, and by purchase through condemnation proceedings, at a total cost of $52,619.05. The two contracts with Messrs. Williams, Green & Williams and Charles S. Barker, for dredging, to the amount of over $2,000,000, have been carried on during the past fiscal year and have resulted in the removal of 2,637,284 cubic yards of material. Of this, 1,970,769 cubic yards have been taken out of Superior and Allouez bays, constituting Dredging District No. 1, and 666,515 cubic yards out of St. Louis Bay, constituting Dredging District No. 2. Of the total amount 1,337,612 cubic yards was dredged out by Charles S. Barker, and 1,299,672 cubic yards by Williams, Green & Williams. Most of the excavated material is dumped in the lake within 2 miles of the entrances, and, as a rule, close in shore to Minnesota Point, to avoid obstructing lake navigation and to reenforce the point. A well organized and efficient system of inspection has been adopted for the work on the respective dredges, for regulating the dumping outside, and for cross-checking the amounts reported by the inspectors on the dredges. Eleven dredges are now at work, and if, by the end of the present season, satisfactory progress is not shown, the contractors will be obliged to put on more plant. In laying out the dredging work the policy has been first to widen and deepen those channels most in use by the commercial marine. The progress map herewith will show what has been done during the past fiscal year, and what is proposed in District No. 1 and part of No. 2.

After extensive advertisement, a contract was made with King & Steele, of Duluth, the lowest bidders, to build the pile and crib substructure for the south pier of the Duluth Canal, amounting to about $171,000. The plans for the new piers and for the concrete superstructure are shown on the maps herewith. The interior arrangement of the latter is not final, and may be changed to secure a stronger form of cross section.

Under the contract with King & Steele the temporary protection crib with superstructure has been built and sunk in place and securely riprapped, and the pierhead crib, 100 by 36 feet, and the first pier crib, 100 by 24 feet, have been nearly completed.

After due advertisement, a contract was made with King & Steele, of Duluth, the lowest bidders, to build 686 concrete footing blocks, each weighing 7 tons. These are to be placed on top of the submerged cribs around their edges, but leaving a 2-foot berm, the tops of the blocks being above water at all stages. Upon the upper faces and between the interior faces of opposite blocks the monolithic concrete work will be built in place. Work has begun under this contract, by preparing the molds, leveling the construction ground and building the necessary mixing platforms, and constructing 23 blocks. The blocks are made of

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American Portland cement, sand, and gravel (taken from the site), in the proportion of 16 pounds of cement to one-half cubic foot of sand and 1 cubic foot of clean gravel. The mixing is done by hand and the concrete is deposited in the molds by shovels and then rammed in 6-inch layers. The plans for the molds are shown in the drawing accompanying. Molds are kept on the blocks for at least twenty-four hours, and no block is moved from the platform to the storage yard until it has stood twelve days.

Contract was made with Frederick Davis, of Duluth, to repair and strengthen the piers at the Superior entrance, with timber work, and with Jacob H. Carlson, of Duluth, to furnish and place in position about 41,000 tons of riprap for the same piers. These contracts are now in force. Under the former, 1,062,000 feet B. M. of timber has been put in place, and under the latter, 13,299 tons of rock.

The contracts yet to be made are for the substructure for the north pier of the Duluth Canal; the superstructure for both piers; for removing and excavating between the new piers; for grading and parking the grounds on each side of the canal; for the superstructure for the piers at the Wisconsin entrance, and for the purchase of land by condemnation next to the south pier at this entrance.

The sundry civil act of July 1, 1898, appropriates $770,138 for this harbor, making $1,207,638 thus far appropriated of the total $3,080,553 authorized to be expended.

The lake commerce of this port, Duluth and Superior, during the last season of navigation amounted to over $118,500,000, as a very conservative valuation, and since the United States took charge of this harbor this commerce has amounted to over $1,018,500,000.

The system of vessel reports has been kept up and the commercial statistics accompany this report.

Comparative table of vessel commerce of the principal ocean and lake ports of the United States, as compiled from the Annual Report of the Chief of Engineers for 1897.

[R., registered; F., freight.]

Name.	Tonnage.	Valuation.
New York	*a* 19, 303, 721 R.	*b* $1, 103, 752, 509
Philadelphia and Delaware River	*a* 15, 268, 365 F.	*a* 623, 896, 493
Chicago, South Chicago, and Michigan City *c*	*a* 14, 394, 736 R.	*d* 120, 000, 000
Duluth-Superior	*a* 13, 353, 068 R.	111, 676, 900
Buffalo	*a* 11, 053, 206 R.	*d* 100, 000, 000
Baltimore	*a* 6, 868, 120 R.	*b* 97, 029, 363
New Orleans	*b* 3, 774, 688 R.	*b* 116, 304, 668
Boston	*a* 3, 578, 190 R.	*a* 194, 765, 282
Portland, Oreg	*a* 696, 796 R.	*b* 8, 346, 824
Savannah	*b* 577, 016 R.	*b* 23, 038, 848
Mobile	*a* 375, 180 F.	*a* 10, 131, 288

a Foreign and domestic.
b Foreign only.
c Chamber of commerce report.
d Estimated.

Attention is invited to the comparative table above, showing the vessel tonnage of eleven of the principal seaboard and lake harbors. This shows that Duluth-Superior harbor is the fourth in the United States in the amount of its vessel tonnage, and sixth as to the value of its marine commerce. The statistics for Duluth-Superior harbor are as accurate as it is practically possible to make them, being compiled from the individual reports of each trip of every vessel in or out made directly to this office. The statistics for the other places are at best but approximations, and are probably exaggerated.

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On September 1, 1897, rules and regulations for the use of the canals and channels in this harbor, were prescribed by the Secretary of War under sections 4 and 5, act of August 18, 1894, and put in operation, to the great convenience of the vessel interests. The principal benefit is the obliging of rafts to go through the Superior Entrance, thus keeping them entirely out of the Duluth Canal, and also to use the rafting spans of the drawbridges, thus leaving the drawspans for the vessels. A copy of these rules and regulations is herewith transmitted:

LAW, RULES, AND REGULATIONS FOR THE CANALS AND CHANNELS IN THE HARBOR AT DULUTH, MINN., AND SUPERIOR, WIS.

THE LAW.

[Section 4 and section 5, act of Congress of August 18, 1894.]

SEC. 4. That it shall be the duty of the Secretary of War to prescribe such rules and regulations for the use, administration, and navigation of any or all canals and similar works of navigation that now are, or that hereafter may be, owned, operated, or maintained by the United States as in his judgment the public necessity may require.

Such rules and regulations shall be posted, in conspicuous and appropriate places, for the information of the public; and every person and every corporation which shall knowingly and willfully violate such rules and regulations shall be deemed guilty of a misdemeanor and, on conviction thereof in any district court in the United States within whose territorial jurisdiction such offense may have been committed, shall be punished by a fine not exceeding five hundred dollars, or by imprisonment (in the case of a natural person) not exceeding six months, in the discretion of the court.

SEC. 5. That it shall be the duty of all persons owning, operating, and tending the drawbridges now built, or which may hereafter be built across the navigable rivers and other waters of the United States, to open, or caused to be opened, the draws of such bridges under such rules and regulations as in the opinion of the Secretary of War the public interests require to govern the opening of drawbridges for the passage of vessels and other water crafts, and such rules and regulations, when so made and published, shall have the force of law. Every such person who shall willfully fail or refuse to open, or cause to be opened, the draw of any such bridge for the passage of a boat or boats, or who shall unreasonably delay the opening of said draw after reasonable signal shall have been given, as provided in such regulations, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not more than two thousand dollars nor less than one thousand dollars, or by imprisonment (in the case of a natural person) for not exceeding one year, or by both such fine and imprisonment in the discretion of the court: *Provided*, That the proper action to enforce the provisions of this section may be commenced before any commissioner, judge, or court of the United States, and such commissioner, judge, or court shall proceed in respect thereto as authorized by law in case of crimes against the United States: *Provided, further*, That whenever, in the opinion of the Secretary of War, the public interests require it, he may make rules and regulations to govern the opening of drawbridges for the passage of vessels and other water crafts, and such rules and regulations, when so made and published, shall have the force of law, and any violation thereof shall be punished as hereinbefore provided.

RULES AND REGULATIONS.

1. No vessels shall be moored to any entry pier.
2. No material of any kind shall be unloaded onto or loaded from the entry piers, except for the use of the United States, unless by special permission of the engineer officer in charge in each case.
3. Vessels shall not anchor in the entrance canals, or in any of the navigable channels, except in the harbor basins, and then only where not in the way of passing vessels.
4. Vessels and rafts shall not be anchored or otherwise fastened where they will be liable to swing into the channels by reason of a wind or current.
5. Vessels and rafts shall take great care not to run into, strike, rub against, or otherwise injure the entrance piers, buoys, or beacons in the harbor.
6. While dredging operations and the rebuilding of the piers are going on, all

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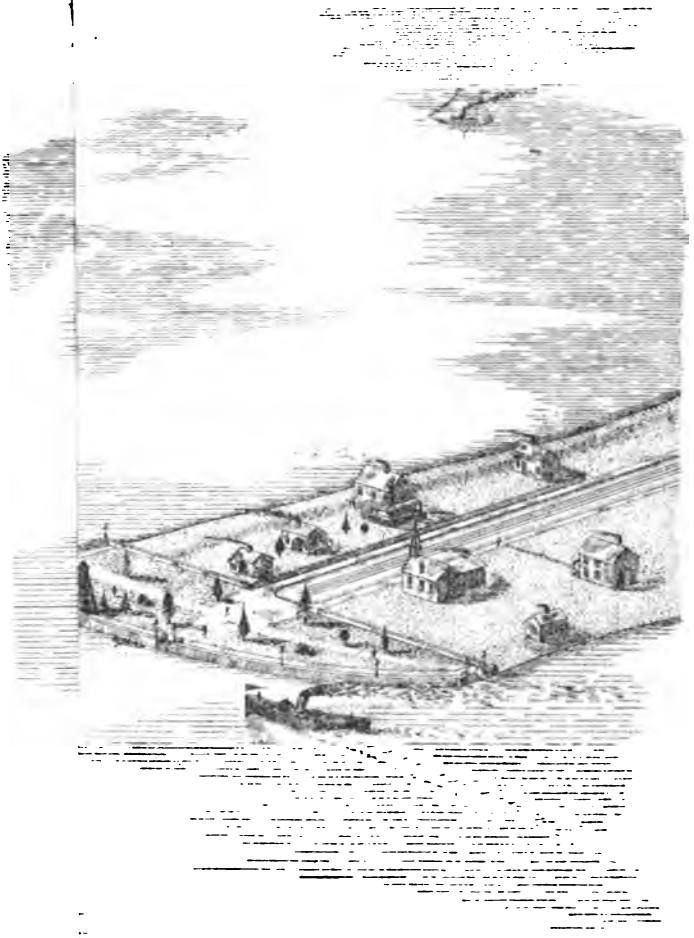

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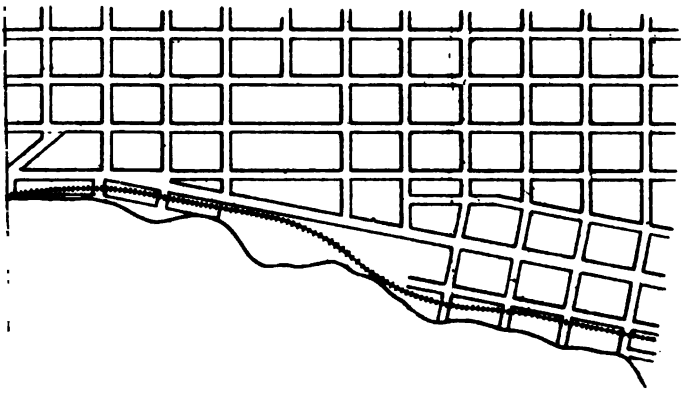

MAP OF
DULUTH CANAL
AND VICINITY.

SHOWING PROPOSED NEW PIERS,

1898.

SCALE OF FEET.

0 1 2 3 4000

, 1898.

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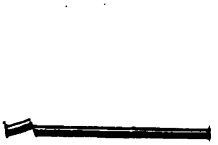

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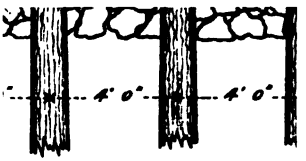

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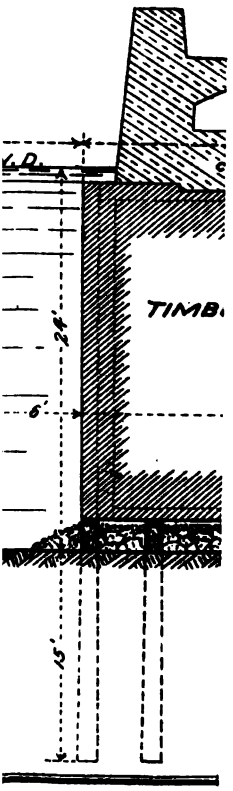

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MY UAL REPORT OF

John B. Sears

ORPS OF ENGINEE

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DULUTH, MINN. MAR. 18, 1898.

THE DIRECTION OF
MAJOR CLINTON B. SEARS,
CORPS OF ENGINEERS, U.S.A.
BY CLARENCE COLEMAN,
U.S. ASSISTANT ENGINEER.

ANY MY ANNUAL REPORT OF JULY 18, 1898.

Clinton B. Sears.

MAJOR, CORPS OF ENGINEERS, U.S.A.

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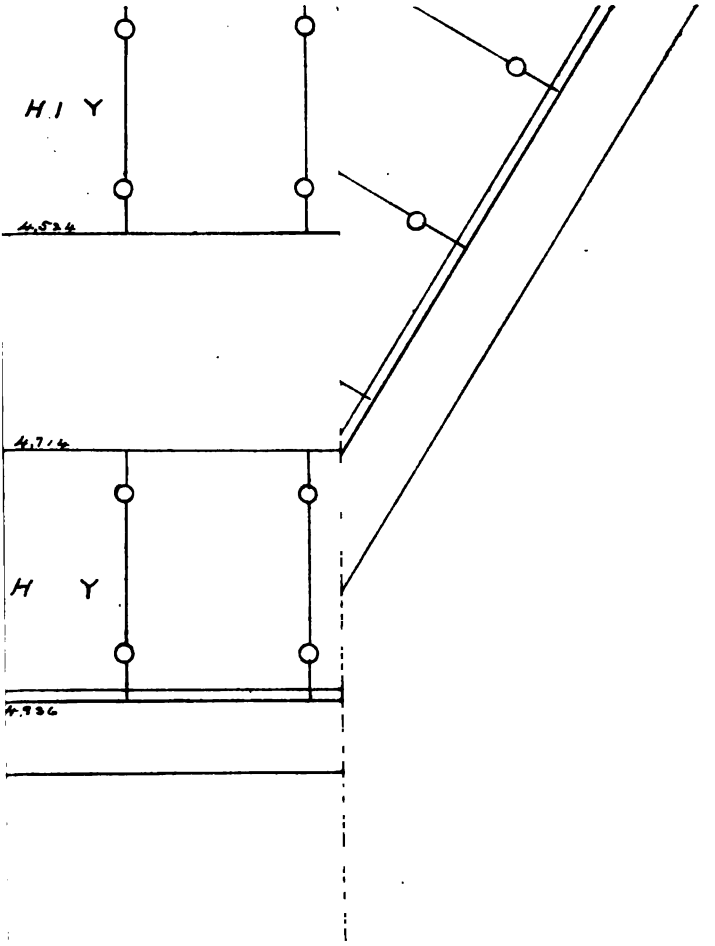

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ıssels will slow down to six miles an hour while passing said piers or the dredges, on being requested to do so by the display or waving of a red flag or red lantern.
'. Dredges and attending scows and tugs are expected, and required to give half › channel for passing vessels and rafts, and the latter are required to do the same ıen passing the dredges or other craft.
ɜ. The signal for opening the draws of all bridges will be three long blasts of the ıistle, or horn where the vessel is not navigated by steam power, and will be given ample time when approaching the bridge. The only exception to this is when a ɜsel going *into* St. Louis Bay from Superior Bay intends to pass through the Wisɔsin draw of the Northern Pacific Bridge; it will then add one short blast after ɜ three long blasts.
). Upon such signal being given, the keeper of the drawbridge, which is signaled, ll open it promptly and fully, and will give all vessels right of way over all trains, rs, wagons, foot passengers, etc.
10. Where there are two or more channels leading to a given point, in one of which provement work is going on, it may be temporarily closed to navigation by the gineer officer in charge, after due notice.
11. All rafts shall enter or leave the harbor by the Wisconsin entrance, and no fts will be permitted to use the Duluth Canal.
12. All rafts in passing the bridges will use the rafting spans, and will not be perıtted to go through the drawspan openings.
13. Rafts at all times will be handled by sufficient number of tugs to enable them avoid obstructing the channels, and to give half the channel to passing vessels, or passing dredges.
These regulations shall be in force from and after September 1, 1897.

G. D. MEIKLEJOHN,
Acting Secretary of War.

Official:
CLINTON B. SEARS,
Major, Corps of Engineers, U. S. A.,
Engineer Officer in Charge of Duluth-Superior Harbor.

The general local charge of this harbor has remained with Mr. J. H. 'arling, assistant engineer, with Mr. F. L. Dever, assistant engineer, ı charge of the dredging, and Mr. Clarence Coleman, assistant engiɜer, in charge of concrete work. Mr. James L. Owen continues as chief .erk, in charge of the office.

This work is in the collection districts of Duluth, Minn., and Superior, Wis.; arquette, Mich., being the port of entry for the latter. The nearest light-houses :e at the two entrances.

Money statement.

ıly 1, 1897, balance unexpended		$448,156.03
mount appropriated by sundry civil act approved July 1, 1898		770,138.00
		1,218,294.03
ıne 30, 1898, amount expended during fiscal year		289,228.62
ıly 1, 1898, balance unexpended		929,065.41
ıly 1, 1898, outstanding liabilities	$18,384.66	
ıly 1, 1898, amount covered by uncompleted contracts	2,060,147.99	
		2,078,532.65
Amount (estimated) required for completion of existing project		1,872,915.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations for improving harbor at Duluth, Minn., and Superior, Wis.

ɜy act of Congress of June 3, 1896	$50,000
ɜy sundry civil act of June 4, 1897	437,500
ɜy sundry civil act of July 1, 1898	770,138
Total	1,257,638

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The following statement shows the manner in which the appropriations (and balances from "Duluth" and "Superior" appropriations) have been expended since June 30, 1896. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies.

Dredging	$257,954.79
Duluth Canal piers	1,009.00
Wisconsin entry piers	34,000.00
Purchase of land	44,617.05
Total	337,571.84

Abstract of appropriations for improving harbor at Duluth, Minn.

By act of Congress approved—	
March 3, 1871	$60,000.00
June 10, 1872	50,000.00
Allotted from act passed March 3, 1873	36,049.20
By act of Congress approved—	
June 23, 1874	10,000.00
March 3, 1875	35,000.00
August 14, 1876	15,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	25,000.00
March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved—	
July 5, 1884	45,000.00
August 5, 1886	56,250.00
By act of Congress passed August 11, 1888	80,000.00
By act of Congress approved—	
September 19, 1890	100,000.00
July 13, 1892	125,000.00
By act of Congress of August 18, 1894	75,000.00
Total	*852,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies.

Total amount expended to June 30, 1896:	
Breakwater	$110,000.00
Dredging	637,237.98
Canal piers, etc	97,660.65
Total	*844,898.63
Expended prior to present project:	
Breakwater	110,000.00
Canal piers, etc	45,698.33
Dredging	114,953.48
Total	270,651.81
Expended under the project adopted in 1881:	
Canal piers, etc	51,962.32
Dredging	522,284.50
Total	574,246.82

* Balance of $7,400.57 taken up under Duluth-Superior appropriation.

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Abstract of appropriations for improving harbor at Superior Bay and St. Louis Bay, Wisconsin.

By act of Congress approved—	
March 3, 1867	$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	63,950.80
Allotted from appropriation for "Repairs of harbors on Northern lakes".	5,433.00
By act of Congress approved—	
August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
August 2, 1882	40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00
By act of Congress—	
Passed August 11, 1888	50,000.00
Approved September 19, 1890	65,000.00
Approved July 13, 1892	70,000.00
Of August 18, 1894	50,000.00
Total	*695,883.80

Expenditures.

Amount expended under original project, adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1896	358,771.86
Total	*694,285.12

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Repairs and beach protection	$13,233.00
Construction and repair to piers	332,679.96
Dredging	348,372.16
Total	*694,285.12

*Balance of $1,598.68 taken up under Duluth-Superior appropriation.

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Abstract of bids received at Duluth, Minn., for repair work and timber sheeting for piers at Superior Entry, opened August 20, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For removing old work, etc., 121,000 feet, B. M., more or less (per 1,000 feet B. M.).	For new timber in place, including fastenings, shifting of stone ballast, and refastening of elevated walk treatle, 153,000 feet B. M., more or less (per 1,000 feet B. M.).	Taking up and relaying 4 and 6 inch plank, nearly new, including fastenings, 10,000 feet, B. M., more or less (per 1,000 feet B. M.).	Rock filling; 100 cords, more or less (per cord of 128 cubic feet).	New timber in place, including iron fastenings and letting into sand bottom by hammer and jet, 147,000 feet, more or less (per 1,000 feet B. M.).	For pointing and driving 5,000 sheet timbers in riprap, more or less (per each timber).	Total.
1	Thomas & Amory, Duluth, Minn	$3.50	$17.50	$3.50	$7.50	$17.50	$0.25	$29,983.50
2	Watterworth & Fee, Duluth, Minn	1.50	15.66	5.50	6.20	17.55	1.00	33,120.83
3	Frankman Bros., West Superior, Wis	3.15	15.65	4.00	6.50	16.30	.36	28,362.70
4	A. & D. Sang, Duluth, Minn	1.00	16.00	6.00	5.00	15.80	.10	26,017.60
5	Frederick Davis, Duluth, Minn *a*	.60	16.00	4.00	7.10	14.50	.08	24,217.10
6	Jacob Zimmerman, Duluth, Minn	2.00	16.38	4.00	5.25	15.95	.47	28,264.29
7	Jonathan N. Dennis, Duluth, Minn	2.00	16.00	3.00	5.75	16.00	.75	29,717.00
8	F. P. Tims, West Duluth, Minn	.75	14.75	5.00	5.50	15.90	.50	27,977.80
9	King & Steele, Duluth, Minn	1.75	17.00	4.00	6.00	15.70	.75	29,449.65
10	Porter Bros., Duluth, Minn	3.00	16.46	5.00	5.50	16.89	.95	32,164.51

a Lowest bidder.

Abstract of bids received in response to public notice, for the construction of a pile dike 800 feet long, at Superior Entry, Wisconsin, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, U. S. A., August 23, 1897.

No.	Name and address of bidder.	For dike complete.
1	Frederick Davis, Duluth Minn	$5,137.40
2	Thomas & Amory, Duluth Minn	11,000.00
3	Porter Bros., Duluth, Minn	6,879.33
4	Jonathan N. Dennis, Duluth, Minn	4,995.00
5	F. P. Tims, West Duluth, Minn	5,200.00

Letter bid and acceptance. No formal contract. Work done by Jonathan N. Dennis. Work begun the latter part of August, 1897, and completed December 15, 1897.

Abstract of bids received in response to public notice, for removing balance of old dike near Minnesota Point, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, September 4, 1897.

No.	Name and address of bidder.	For removing dike, per linear foot.	For use dredging plant, per hour actual work.
1	Duluth Dredge and Dock Co., Duluth, Minn	$1.45	$9.50
2	Williams, Green & Williams, Duluth, Minn	2.00	9.00

Letter bid and acceptance. No formal contract. Work done by Duluth Dredge and Dock Company during the month of September, 1897, amounting to about $500.

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Abstract of bids received in response to public notice, for furnishing and placing riprap at Superior Entry piers, Wisconsin, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, September 15, 1897.

No.	Name and address of bidder.	For derrick rock in place, about 29,000 tons, more or less (of 2,000 pounds), per ton.	Small rock in place, about 11,000 tons, more or less (of 2,000 pounds), per ton.	Total.
1	MacLeod, Campbell & Smith, Duluth, Minn	$1.35	$0.90	$49,050
2	Jacob H. Carlson, Duluth, Minn	.71	.71	28,400
3	Alexander Pearson & A. Fredin, Duluth, Minn	.83	.83	33,200
4	Frederick Davis, Duluth, Minn	1.04	.729	33,179
5	King & Steele, Duluth, Minn	1.72	.80	58,680
6	Porter Bros., Duluth, Minn	1.18	.85	43,570
7	Patrick J. McKeon, Rush City Minn	1.03	1.03	41,200
8	Duluth Brown Stone Co., Duluth, Minn	.77	.77	30,800
9	Ashland Brownstone Co., Chicago, Ill	2.23	1.08	76,550
10	Heldmaier & Neu, Chicago, Ill	3.60	.67	111,770

Abstract of bids received in response to public notice, for building boathouse at Connors Point, West Superior, Wis., opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, September 20, 1897.

No.	Name and address of bidder.	Amount of bid.
1	Moran & O'Brien, West Superior, Wis	$386.57
2	Evens & Grandy, Duluth, Minn	487.00
3	Schmidt Bros., West Superior, Wis	675.00

Letter bid and acceptance. No formal contract. Work done by Moran & O'Brien; begun in the latter part of September, 1897, and completed October 19, 1897.

Abstract of bids received in response to public notice, for building boathouse, warehouse, dock, oil house, etc., for Duluth-Superior Harbor, opened at Duluth, Minn., by Maj. Clinton S. Sears, Corps of Engineers, October 8, 1897.

No.	Name and address of bidder.	All white pine.		Part Norway pine.	
		Iron roof.	Iron and shingle.	Iron roof.	Iron and shingle.
1	Thomas & Amory, Duluth, Minn	$5,150.00	$5,000.00	$5,150.00	$5,000.00
2	Frankmann Bros., West Superior, Wis	4,279.00	4,437.00	4,239.00	4,437.00
3	J. N. Dennis & Alex. Kennedy, Duluth, Minn.	4,420.25	4,505.25	4,370.25	4,420.25
4	J. F. Schleunes, Duluth, Minn	4,615.00	4,552.00	4,585.00	4,522.00
5	MacLeod, Campbell & Smith, Duluth, Minn	3,617.00	3,727.00	3,577.00	3,687.00
6	F. P. Tims, West Duluth, Minn	3,292.00	3,216.00	3,252.00	3,176.00
7	Frederick Davis, Duluth, Minn	4,500.00	4,302.00	4,302.00	4,102.00
8	Theophilus Nauffts, Duluth, Minn	4,250.00	.....	4,220.00	4,250.00
9	Nicholas Mueller, Duluth, Minn	4,535.00	4,500.00	4,475.00	4,440.00

Letter bid and acceptance. No formal contract. Work done by F. P. Tims; begun October 12, 1897, and completed about December 20, 1897. Cost about $3,300.

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Abstract of bids received in response to advertisement, for building substructure for south pier of ship canal entrance to harbor at Duluth, Minn., opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, January 15, 1898.

Name and address of bidder.	For dredging trench for canal pier, and for protection pier or piers, 72,000 cubic yards, more or less (per cubic yard).	For pine or hemlock timber in accessory works in place, 550,000 feet B. M., more or less (per 1,000 feet B. M.).	For round piles in place in accessory works, 16,000 linear feet, more or less (per linear foot).	For flattened piles in place in accessory works, 30,000 linear feet, more or less (per linear foot).	For steel driftbolts and spikes in place in accessory works, 51,000 pounds, more or less (per pound).	For steel machine bolts in place in accessory works, 15,000 pounds, more or less (per pound).	For cast-iron washers in place in accessory works, 5,000 pounds, more or less (per pound).
Porter Bros., Duluth, Minn...	$0.12½	$17.70	$0.12	$0.13¾	$0.02½	$0.02½	$0.02½
James L. Lipsett & Robert Gregg, Sault Ste. Marie, Mich.....	.10	16.00	.12	.13	.01⅝	.01⅝	.01½
Heldmaier & Neu, Chicago, Ill.....	.17	18.00	.16	.18	.02 9/10	.03⅜	.02½
Adolph Green, Green Bay, Wis.....	.12	15.50	.13	.19	.02½	.03½	.02½
The L. P. & J. A. Smith Co., Cleveland, Ohio	.12	15.00	.15	.18	.03½	.04½	.03
P. McDonnell, Duluth, Minn .	.15	18.00	.13	.15	.02	.02	.03
N. Frederick Hugo & Frank P. Tims, Duluth, Minn.....	.07 6/10	18.00	.11½	.12½	.02	.02½	.01½
Carkin, Stickney & Cram, Detroit, Mich.....	.15	16.50	.15	.20	.03	.04	.02
McMullen & Morris, St. Paul, Minn.....	.12	15.50	.12	.13	.01⅝	.01 9/10	.01⅝
James B. Donnelly, Buffalo, N. Y	.09½	16.00	.10	.12	.02⅛	.03	.02⅛
King & Steele, Duluth, Minn. a	.10½	15.65	.10	.11	.01 41/100	.01 41/100	.01 7/10
Frank Campbell, Duluth, Minn.....	.12½	18.00	.14	.14	.02	.02	.02
The Barnett & Record Co., Minneapolis, Minn	.10 1/10	16.50	.09½	.10½	.01½	.01 41/100	.01 1/10
Norris & Fitzgerald, Duluth, Minn.....	.12½	18.00	.14	.16	.03	.03	.03
A. F. Chapman & Co., Buffalo, N. Y	.19	28.00	.25	.32	.03	.03½	.03

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Abstract of bids received in response to advertisement, for building substructure for south pier of ship canal entrance to harbor at Duluth, Minn., etc.—Continued.

Name and address of bidder.	For rock filling in canal pier cribs, and between bearing piles, in protection piers, and riprap, etc., in place, 30,000 tons, more or less (per ton of 2,000 tons).	For gravel filling in place, 10,000 cubic cubic yards, more or less (per cubic yard).	For gravel excavated and deposited in a stock pile, 15,000 cubic yards, more or less (per cubic yard).	For timber in accessory works, taken up and rebuilt, including old fastenings, 20,000 feet B. M., more or less (per 1,000 feet B. M.).	For piles taken up and redriven, 3,000 linear feet, more or less (per linear foot).	For 1,722 linear feet canal pier cribs, exclusive of rock and gravel. Complete. (A lump sum of.)	Total.
Porter Bros., Duluth, Minn...	$0.90	$0.40	$0.35	$8.00	$0.09	$153,787	$217,009.50
James L. Lipsett & Robert Gregg, Sault Ste. Marie, Mich	.90	.20	.20	10.00	.08	146,350	201,840.00
Heldmaier & Neu, Chicago, Ill	.98	.45	.15	17.50	.15	165,019	234,235.50
Adolph Green, Green Bay, Wis	.95	.50	.45	10.00	.14	138,517	207,057.00
The L. P. & J. A. Smith Co., Cleveland, Ohio	1.00	.25	.35	20.00	.20	120,540	186,590.00
P. McDonnell, Duluth, Minn	.70	.30	.10	4.00	.07	130,000	184,540.00
N. Frederick Hugo & Frank P. Tims, Duluth, Minn	.95	.45	.15	10.00	.08	121,850	179,972.00
Carkin, Stickney & Cram, Detroit, Mich	1.50	.40	.30	12.00	.15	121,700	206,395.00
McMullen & Morris, St. Paul, Minn	1.10	.35	.17	10.00	.10	120,500	184,300.00
James B. Donnelly, Buffalo, N. Y	1.10	.29	.25	7.50	.11	119,000	181,820.00
King & Steele, Duluth, Minn. *a*	.72	.55	.22	6.00	.07	117,800	170,779.50
Frank Campbell, Duluth, Minn	.90	.50	.30	8.00	.07	149,000	212,636.00
The Barnett & Record Co., Minneapolis, Minn	.63	.40	.27 1/2	9.50	.06 1/2	134,287	183,721.50
Norris & Fitzgerald, Duluth, Minn	.61	.40	.28	36.00	.14	151,000	206,710.00
A. F. Chapman & Co., Buffalo, N. Y	2.50	.40	.50	20.00	.35	208,000	340,835.00

a Lowest bidder.

Abstract of bids received in response to public notice, for removing wreck of steamship Winnipeg from Duluth Harbor, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, March 7, 1893.

No.	Name and address of bidder.	Amount of bid.
1	King & Steele, Duluth, Minn	$2,950
2	Osborne & Co., Duluth, Minn	1,790
3	Napoleon Grignon, Duluth, Minn	2,375
4	Hugh Campbell, James Magee, & J. W. Fee, Duluth, Minn	5,000
5	Frank Campbell, Duluth, Minn	3,200

All bids rejected on account of being too high. After further solicitation, a bid was received from Capt. B. B. Inman, of Duluth, Minn., to do the work for $1,300, and the contract was awarded to him as being the lowest responsible bidder. Letter bid and acceptance. No formal contract.

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Abstract of proposals received in response to advertisement, for building concrete footing blocks for the superstructure for the south pier of ship canal entrance to harbor at Duluth, Minn., opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, April 11, 1898.

No.	Name and address of bidder.	For footing blocks complete, per cubic yard of concrete.
1	Michael Rabbitt, Toledo, Ohio	$18.09
2	Norris & Fitzgerald, Duluth, Minn	5.47
3	Stamsen & Blome, Chicago, Ill	5.93
4	Davis & Davis, Duluth, Minn	6.74
5	Nilson & Carlson, Duluth, Minn	5.67
6	Frank Campbell, Duluth, Minn	6.90
7	G. H. Sager, Chicago, Ill	6.20
8	King & Steele, Duluth, Minn	4.95
9	Emil Engle & Aquila G. Osman, Duluth, Minn	8.49
10	Lipsett & Gregg, Sault Ste. Marie, Mich	8.69
11	John F. Schleunes, Duluth, Minn	5.68

LIST OF EXISTING CONTRACTS.

Contracts for dredging some 26,400,000 cubic yards of material, more or less, with Williams, Green & Williams, of Duluth, Minn., for one-half; contract dated March 18, 1897, approved April 29, 1897; work commenced June, 1897, and, to be completed by November 1, 1903, contingent upon appropriations being made. Charles S. Barker, of West Superior, for one-half; contract dated March 18, 1897, approved May 8, 1897; work begun in June, 1897, and to be completed by November 1, 1903, contingent upon appropriations being made.

Contract for building substructure for south pier, Duluth Canal, with King & Steele, of Duluth, Minn. Contract dated January 24, 1898. Approved February 14, 1898. Work commenced about middle of April, 1898, and to be completed by December 1, 1899.

Contract for building concrete footing blocks, for superstructure for south pier, Duluth Canal, with King & Steele, of Duluth, Minn. Contract dated April 30, 1898. Approved May 16, 1898. Work commenced May 15, 1898, and to be completed November 1, 1898.

Contract with Jacob H. Carlson, Duluth, Minn., for placing 7,000 cords of riprap at base of piers, Superior Entry, Wisconsin. Contract dated and work commenced September 28, 1897. Approved by Chief of Engineers October 9, 1897. To be completed November 15, 1898.

For Superior Entry pier repairs by Frederick Davis, Duluth, Minn. Informal contract dated August 9, 1897, after bids through public notice. Work commenced August, 1897, and will be completed early in July, 1898.

Informal contract, after public notice, with B. B. Inman, Duluth, Minn., for removing steamer *Winnipeg* from Superior Bay, for $1,300. Work commenced in May, 1898, and will be completed in July, 1898.

COMMERCIAL STATISTICS, DULUTH, MINN.

Comparative statement of arrivals and clearances for 1896 and 1897.

Year.	Arrivals.	Clearances.	Total.	Tonnage.	Average tonnage.
1896	3,737	3,686	a 7,423	8,668,811	b 1,257
1897	3,120	3,109	a 6,229	8,004,473	b 1,386
Increase	−617	−577	−1,194	−664,338	+129

a Steam, 4,892; sail, 1,337.

b Exclusive of tugs with freight.

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Principal domestic commodities received and shipped by lake, 1897.

Receipts.	Tons.	Shipments.	Tons.
Coal	682,274	Wheat	531,061
Cement and lime	28,725	Flour	356,083
Building stone	1,957	Other grains	175,164
Salt	20,408	Structural iron or steel	385
Machinery	351	Iron ore	2,342,679
Manufactured iron	24,596	Copper	6,727
Fish, kerosene oil, etc	846	Miscellaneous merchandise	19,308
General merchandise	123,378	Lumber	456,752
Sand	3,068	Wool	2,298
Total	*a* 885,623	Total	3,890,457

	Net tons.	Valuation.
Total receipts	885,623	*b* $16,378,660
Total shipments	3,890,457	38,881,407
Receipts and shipments	4,776,080	55,260,067

a These figures do not include some 79,290,000 feet of logs in rafts.
b Valuations are based on average wholesale prices on board vessels for exports and landed on docks for imports.

Passengers, arriving	22,451
Passengers, departing	22,075
Total	44,526

Receipts of coal and shipments of flour eastward for fifteen years.

Year.	Coal.	Flour.	Year.	Coal.	Flour.
	Tons.	*Tons.*		*Tons.*	*Tons.*
1883	420,000	91,896	1891	778,982	170,774
1884	372,000	79,801	1892	1,168,068	288,483
1885	695,000	113,190	1893	1,124,771	301,988
1886	736,000	133,036	1894	932,679	546,580
1887	1,041,000	129,627	1895	581,682	407,003
1888	1,435,000	171,223	1896	662,123	372,944
1889	1,045,000	193,053	1897	682,274	356,083
1890 *a*	735,995	149,112			

a Coal receipts prior to 1890 are given for the head of the lake (Duluth and Superior); since then for Duluth only.

The storage capacity of Duluth elevator system is 24,650,000 bushels, and that of Duluth elevators proper 11,350,000 bushels. The following table gives the receipts and shipments of wheat for twenty-seven years:

Year ending—	Receipts.	Shipments.	Total.
December 31—	*Tons.*	*Tons.*	*Tons.*
1897	1,442,082	1,141,259	2,583,341
1896	1,748,780	1,296,862	3,045,642
1895	1,487,981	1,092,516	2,580,497
1894	750,000	763,110	1,513,000
1893	987,312	1,011,025	1,998,337
1892	1,399,617	932,322	2,332,089
1891	1,144,082	1,058,449	2,202,531
1890	460,244	427,725	887,969
1889	513,827	409,410	923,237
1888	239,502	404,485	644,287
1887	514,089	585,558	1,059,647
1886	675,977	530,048	1,206,025
1885	446,590	421,973	868,563
1884	411,688	345,537	758,235

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Year ending—	Receipts.	Shipments.	Total.
August 31—	*Tons.*	*Tons.*	*Tons.*
1883	141,234	137,607	278,841
1882	97,987	99,264	197,251
1881	99,965	85,966	185,931
1880	40,430	43,610	84,040
1879	54,722	44,617	90,339
1878	54,092	54,000	108,092
1877	13,817	15,117	28,934
1876	43,536	41,292	84,828
1875	34,137	32,436	66,573
1874	67,224	72,725	139,949
1873	59,444	47,495	106,939
1872	27,948	28,531	56,479
1871	16,703	16,345	33,048

The above figures show the movement of wheat at the head of the lake (Duluth and Superior combined).

Average vessel tonnage for thirteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1885	761	1890	1,081	1894	1,217
1886	778	1891	1,129	1895	1,172
1887	812	1892	1,095	1896	1,257
1888	887	1893	1,160	1897	1,386
1889	970				

Comparative statement of arrivals and clearances of vessels at Duluth for twenty-one years.

Year.	Arrivals.	Clearances.	Total.	Year.	Arrivals.	Clearances.	Total.
1877	329	228	557	1888	1,100	1,100	2,200
1878	406	343	749	1889	1,263	1,265	2,528
1879	502	497	999	1890	1,266	1,268	2,534
1880	524	524	1,048	1891	1,444	1,451	2,895
1881	666	660	1,326	1892	1,735	1,747	3,482
1882	833	832	1,665	1893	1,642	1,663	3,305
1883	796	779	1,475	1894	2,234	2,280	4,514
1884	888	903	1,791	1895	3,786	3,782	7,568
1885	808	989	1,979	1896	3,737	3,686	7,423
1886	1,026	995	2,021	1897	3,130	3,109	6,229
1887	1,237	1,238	2,475				

Comparative statement of imports and exports.

Year.	Imports.	Duties.	Tonnage duty.	Total duties.	Value of domestic exports.	Value of foreign exports.
1888	$86,901	$2,909.00	$23.40	$2,932.40	$1,207,858	.....
1889	21,852	2,931.00	49.80	2,980.80	1,405,447	.....
1890	48,027	5,255.86	13.20	5,269.06	1,521,751	.....
1891	155,446	4,764.97	86.40	4,851.37	2,079,173	.....
1892	117,759	16,706.28	127.84	16,834.12	1,837,936	.....
1893	130,797	14,496.34	154.89	14,651.23	1,419,699	.....
1894	111,340	10,163.90	82.62	10,246.52	1,696,950	$815,356
1895	1,350,264	254,435.92	114.06	254,549.98	2,200,164	1,224,086
1896	1,154,123	220,688.81	95.46	220,734.27	2,857,742	1,075,379
1897	2,167,822	520,201.54	.....	520,201.54	2,230,834	2,009,685

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Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27	Nov. 29	1892	Apr. 16	Dec. 30
1886	May 7	Dec. 14	1893	May 9	Dec. 1
1887	May 4	Dec. 28	1894	Apr. 19	Dec. 15
1888	May 11	Dec. 31	1895	Apr. 15	Dec. 16
1889	Apr. 11	Dec. 4	1896	Apr. 12	Dec. 17
1890	Apr. 16	Dec. 8	1897	Apr. 15	Dec. 14
1891	Apr. 30	Dec. 6	1898	Apr. 5	

Detailed statement of arrivals, clearances, and registered tonnage of vessels through the Duluth Canal for the season of 1897.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
April	74	72	146	181,387
May	387	396	783	1,015,092
June	502	494	996	1,196,761
July	464	463	927	1,074,020
August	459	458	917	1,161,742
September	456	436	892	1,143,981
October	395	398	793	1,068,079
November	319	326	645	933,326
December	64	66	130	230,085
Total	3,120	3,109	6,229	8,004,473

Total tons cargo received through Duluth Canal	1,989,807
Total tons cargo departing through Duluth Canal	4,991,362
Total tons cargo entering and departing through Duluth Canal	6,981,169

Vessel report for Duluth Canal, season of 1897.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which came through Duluth Canal and discharged—			
At Duluth	781	778,671	798,297
At Superior	499	676,206	1,012,089
At Duluth (87,326 tons); at Superior (92,095 tons)	282	407,017	179,421
Number which came through Duluth Canal light or with passengers	1,558	2,120,901	.....

DEPARTING.

Number which departed through Duluth Canal with cargo from Duluth	1,684	2,330,565	3,397,371
Number which departed through Duluth Canal with cargo from Superior	276	416,497	682,704
Number which departed through Duluth Canal with cargo from Duluth (493,086 tons) and Superior (418,201 tons)	411	565,803	911,287
Number which departed through Duluth Canal light or with passengers	788	708,813	.....

NEW LINES OF TRANSPORTATION.

Canada Atlantic Line, 5 steamers.
Howard's South Shore Line, 1 steamer.
Georgian Bay and Lake Superior Transit Line, 2 steamers.

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Commerce for the head of the lakes (Duluth, Minn., and Superior, Wis., combined), for the navigation season of 1897.

Receipts.	Tons.	Shipments.	Tons.
Anthracite coal	674,076	Iron ore	2,868,012
Bituminous coal	1,475,305	Copper	51,072
Building stone	2,793	Flour	797,920
Salt	40,224	Wheat	1,141,259
Machinery	426	Other grains	506,464
Manufactured iron	64,360	Structural iron or steel	521
General merchandise	176,457	Wool	6,470
Lime and cement	30,321	Merchandise	38,540
Kerosene oil	24,058	Lumber	572,546
Fish	652		
Sand	3,848		
Total	2,492,420	Total	5,982,804

Total tons cargo entered and departed	8,475,224
Valuation	$118,551,185
Total arrivals and departures	9,758
Registered tonnage	12,845,865

Arrivals and clearances of vessels at Superior, Wis., for two years.

Year.		Arrivals and clearances.	Average vessel tonnage.	Tonnage.
1897:				
Steam	3,021	3,529	a 1,500	4,341,393
Sail	508			
1896:				
Steam	3,082	3,525	a 1,446	4,684,257
Sail	443			
Increase		4	54	157,135

a Exclusive of tugs.

The storage capacity of the Superior elevators is 13,500,000 bushels.

Vessel report for Superior Harbor for season of 1897.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which entered Superior Harbor via Duluth Canal	781	1,083,223	1,104,184
Number which entered Superior Harbor light via Duluth Canal	231	432,100	.....
Number which came in Wisconsin Entry and discharged at Superior	251	371,837	a 502,613
Number which entered Wisconsin Entry light or with rafts in tow	381	472,113	.....
Total	1,744	2,359,323	1,606,797

DEPARTING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which took cargo from Superior and departed through Duluth Canal	687	962,300	1,100,905
Number which left Superior light and departed through Duluth Canal	232	318,712	.....
Number which loaded at Superior and departed through Wisconsin Entry	434	731,249	991,442
Number which left Superior light and took cargo on at Duluth and departed via Duluth Canal	227	304,560	.....
Number which departed through Wisconsin Entry light or with booms in tow	b 215	145,248	.....
Total	1,785	2,482,069	2,092,347

a These figures do not include 33,334,000 feet of logs towed in through the entry by tugs.
b These figures do not include tugs which passed in and out of the entry with dump scows or with vessels in tow.

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Vessel report for Wisconsin Entry for season of 1897.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which came through Wisconsin Entry and discharged at Superior	251	371,887	a 502,613
Number which came through Wisconsin Entry light or with rafts in tow	381	472,113	.....

DEPARTING.

Number which took cargo from Superior and departed through Wisconsin Entry	424	731,249	991,442
Number which departed through Wisconsin Entry light or with booms in tow	215	145,248	.....

a These figures do not include 33,334,000 feet of logs towed in through the entry by tugs.

Shipments and receipts by lake of leading articles during season of 1897.

Shipments.	Tons.	Receipts.	Tons.
Wheat	610,198	Coal	1,467,107
Other grain	331,300	Cement and lime	1,596
Wool	4,172	Kerosene oil	23,800
Flour	441,337	Salt	19,816
Structural iron	136	Miscellaneous	94,478
Copper ore	44,345		
Lumber	115,794		
Iron ore	525,333		
Merchandise	19,232	Total	1,606,797
		Total receipts and shipments	3,699,144
Total	2,092,347	Total value	$63,291,118

Passengers departing	4,291
Passengers arriving	3,594

Valuations are based on average wholesale prices on board vessels for exports and landed on docks for imports.

Comparative statement of receipts and shipments for fourteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1884	17,462	1889	1,006,542	1894	2,598,264
1885	33,626	1890	1,495,385	1895	2,577,281
1886	117,027	1891	1,616,648	1896	2,995,067
1887	170,020	1892	1,783,444	1897	3,699,144
1888	327,327	1893	1,913,350		

Detailed statement of arrivals and clearances of vessels at Superior, Wis., for season of 1897.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
April	33	42	75	128,105
May	236	233	469	654,487
June	302	288	590	786,743
July	224	244	468	552,240
August	226	239	465	557,844
September	232	230	462	591,591
October	244	252	496	721,298
November	198	210	408	692,127
December	49	47	96	196,957
Total	1,744	1,785	3,529	4,841,392

Average tonnage per vessel, exclusive of tugs, 1,500.

Of the number of vessels reported above for 1897, there were 3,021 steam and 508 sailing vessels. The steamers were divided as follows: 2,505 freight propellers, 207 passenger and freight combined, and 309 tugs.

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Comparative statement of arrivals and clearances of vessels for fourteen years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1884	194	119,288	1891	1,610	2,984,463
1885	200	113,519	1892	1,940	2,498,507
1886	316	283,787	1893	1,909	2,571,917
1887	462	404,780	1894	2,000	2,829,968
1888	812	915,816	1895	3,418	4,042,992
1889	900	1,122,048	1896	3,525	4,684,257
1890	1,256	1,541,777	1897	3,529	4,841,392

NEW LINES OF TRANSPORTATION.

Canada Atlantic Line, 5 steamers.
Howard's South Shore Line, 1 steamer.
Georgian Bay and Lake Superior Transit Line, 2 steamers.

H H 4.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

The southern end of Chequamegon Bay forms the harbor of Ashland, and as the length of the bay is considerable it was necessary to protect the wharves from the waves to enable vessels to use them at all times.

The approved project is for the construction of a pile, slab, and rock breakwater 8,000 feet long, and for dredging a channel of the necessary depth along the dock line. The present length of the breakwater is 7,363 feet. This length gives a protected area of some 1,600 acres and affords a safe anchorage and dockage for 3 miles along the city front.

The amount expended on this harbor up to the close of the fiscal year ending June 30, 1897, is $220,847.98, of which $127,000 has been for the construction of the breakwater, $53,539.71 for repairs to same, $31,000 for closing the breach in Chequamegon Point and repairing the same, and $9,308.27 for dredging.

At that time the breakwater had fully accomplished the object of its construction and will continue to do so as long as it is kept in repair. It consists of three rows of piling filled in between with slabs which are anchored with large rock.

This construction has only its original cheapness to commend it. It is proving very expensive to maintain. All of the preceding and nearly half of the last appropriation have been expended in strengthening the older portion of the work.

The contract with Charles S. Barker for dredging in the harbor parallel to and 150 feet from the harbor line, in force at date of the last annual report, was completed September 22, 1897, and resulted in the dredging of 110,073 cubic yards of material which was deposited against the breakwater. The resulting channel, having an average width of 124 to 150 feet, with a navigable depth of 20 feet, extends from opposite Ellis avenue to a point in prolongation of Eleventh avenue west, a distance of about 3,460 feet. After the dredging had been completed the dredge was placed at work on the line of deposit near the breakwater and the material along the toe of the outer slope was cast up against the piling, thus greatly strengthening the work.

To complete the breakwater as originally projected will cost $20,000. Much stronger work should be put in, however, and it will be economy to spend on the remaining 637 feet $30,000 instead of $20,000.

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At the request of the city council a harbor line was established by the Secretary of War March 13, 1896. There is no uniformity of depth along this line, however, and to complete the channel 200 feet wide, with a navigable depth of 16 feet, will require the excavation of 425,000 cubic yards of material at a cost of $93,500, providing no bed rock or hardpan is encountered.

At an early day the breakwater should be extended in toward shore to protect the commercial interests which are increasing in the easterly part of the town, and I was urged by prominent citizens to use the last appropriation for this purpose. The necessity, however, for holding on to the old work and protecting it was so urgent that I expended the money as herein set forth, the dredging having been done more to get material for embankment than to meet any immediate needs of navigation.

The principal shipments from Ashland are iron ore and lumber. Congress has appropriated between 1886 and 1898, both inclusive, $239,500 for the improvement of this harbor.

The commerce of this port during this period has increased from 892 arrivals and clearances, with cargo tonnage of 1,400,000 tons, in 1887, to 5,164 arrivals and clearances, with cargo tonnage of 2,400,000 tons, in 1896. During this period the commerce of this port is roughly estimated at a valuation of $300,000,000. (Unable to get statistics for 1897.)

The work during last season remained under the exclusive charge of Mr. E. H. Foster, inspector.

This work is in the collection district of Superior, Mich., Marquette, Mich., being the port of entry; nearest light-house, La Pointe, on Chequamegon Point, at entrance of Chequamegon Bay.

Money statement.

July 1, 1897, balance unexpended	$18,652.02
June 30, 1898, amount expended during fiscal year	16,656.00
July 1, 1898, balance unexpended	1,996.02
Amount (estimated) required for completion of existing project	346,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Recommendations.

For 637 feet extension to the breakwater	$30,000
For repairs and contingencies	240,000
For dredging	76,500
Total	346,500

Abstract of appropriations for improving harbor at Ashland, Wis.

By act of Congress—	
Approved August 5, 1886	$22,500
Of August 11, 1888	60,000
Approved September 19, 1890	60,000
Approved July 13, 1892	45,000
Of August 18, 1894	25,000
Passed June 3, 1896	27,000
Total	239,500

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COMMERCIAL STATISTICS.

[Very unreliable and unsatisfactory.]

NOTE.—Letters of request for statistical information were written to the deputy collector of customs, the secretary of the Business Men's Association, and Mr. Chappell, of one of the daily papers at Ashland, who has heretofore furnished the information, and no reply to either was received. Reports for previous years follow:

Arrivals and clearances of vessels (Chequamegon Bay, including Washburn and Bayfield, Wis.) for four years.

Year.	Number.	Average tonnage.
1893	6,052	1,178
1894	6,142	.....
1895	5,227	.....
1896	5,164	.....

Principal articles of export and import for 1896.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Pig iron	50,000	Coal	200,000
Iron ore	1,566,337	Oil	30,000
Stone, building	120,000	Salt, lime, and cement	25,000
Lumber	300,000	Merchandise and miscellaneous	100,000
Total	2,036,337	Total	355,000
		Total exports and imports	2,391,337

Comparative statement of receipts and shipments for ten years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,401,454	1891	3,217,541	1895	3,747,251
1888	1,357,472	1892a	4,267,097	1896	2,391,337
1889	1,971,213	1893	2,759,870		
1890	2,816,924	1894	2,982,502		

Arrivals and clearances of vessels for ten years.

Year.	Number.	Year.	Number.	Year.	Number.
1887	892	1891	4,099	1895	5,227
1888	2,375	1892a	7,104	1896	5,164
1889	3,171	1893	6,052		
1890	4,489	1894	6,142		

a Since 1892 report includes the ports of Washburn and Bayfield, on Chequamegon Bay.

H H 5.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

This harbor is formed by the mouth of the Ontonagon River, which flows out between two piers, 2,315 and 2,675 feet in length, respectively. The project is for maintaining a navigable depth of 12 feet between these piers and up to the bridge just inside the entrance. This is done

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by dredging annually or biennially, as may prove necessary, at an annual cost of from $5,000 to $10,000.

For the history of this improvement see Annual Report for 1896.

The total cost of the improvement to June 30, 1897, has been $335,448.64, at which time there was a good navigable 12-foot channel, which has remained in good shape.

The balance of the $10,000 appropriated by the act of June 3, 1896, is being held for emergencies, such as accidents to the piers by storms, ice, etc., requiring renewals, and for dredging as soon as the ruling depth of 12 feet between the piers becomes materially impaired.

A fire in August, 1896, almost obliterated the town, destroying all its commercial industries, and wiping out most of the business and residence portions.

Of late years the annual commerce has been roughly estimated at $1,000,000. The great fire, however, destroyed the principal commercial industry—the plant of the Diamond Match Company, and this the company has not rebuilt.

No appropriation is recommended for the next fiscal year.

This work is in the collection district of Superior, Mich. Nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich.

Money statement.

July 1, 1897, balance unexpended	$9,679.36
June 30, 1898, amount expended during fiscal year	756.25
July 1, 1898, balance unexpended	8,923.11

Abstract of appropriations for improving harbor at Ontonagon, Mich.

By act of Congress—		By act of Congress—	
Approved March 2, 1867	$97,600	Approved August 5, 1886	$13,000
Approved July 7, 1870	10,000	Passed August 11, 1888	12,500
Approved June 23, 1874	23,000	Approved September 19, 1890	10,000
Approved March 3, 1875	25,000	Approved July 13, 1892	20,000
Approved August 14, 1876	15,000	Passed August 7, 1894	7,000
Approved June 18, 1878	15,000	Passed June 3, 1896	10,000
Approved March 3, 1879	17,000	Received on account of damage to piers	28
Approved June 14, 1880	15,000		
Approved March 3, 1881	20,000	Total	345,128
Passed August 2, 1882	20,000		
Approved July 5, 1884	15,000		

Expenditures.

Amount expended under the approved project to date	$336,204.89
Balance unexpended July 1, 1898	8,923.11

COMMERCIAL STATISTICS, ONTONAGON, MICH.

During the fall of 1896 a fire destroyed the town and records of Ontonagon, and a letter from the principal dock owner states as follows: "There has been but little lake business here since the year of 1896." The last report received from this port was for the season of 1895, which is given below:

Arrivals and clearances of vessels for 1895.

	Arrivals.		Clearances.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	365	69,300	363	69,190
Sail	129	79,000	129	79,000
Total	494	148,300	492	148,190

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Arrivals and clearances of vessels for three years.

	1893.	1894.	1895.
Arrivals	a77	211	494
Clearances	77	211	492

a In addition there were a number of arrivals during the season of both steam and sailing vessels seeking refuge during heavy weather, and frequent arrivals of fishing and other tugs.

Principal articles of export and import for 1895.

Imports.	Tons.	Exports.	Tons.
Fish	200	Saw logs	80,000
General merchandise	900	Lumber	94,500
Coal	700	Laths	2,500
		Pickets	2,000
		General merchandise	250
Total	1,800	Total	179,250

Receipts and shipments for three years.

	Tons.
1893	178,100
1894	182,790
1895	181,050

H H 6.

IMPROVEMENT AND OPERATING AND CARE OF WATERWAY FROM KEWEENAW BAY TO LAKE SUPERIOR, MICHIGAN.

This work was reported upon in the Report of the Chief of Engineers for 1892 (Appendix I I 1) under the title of "Portage Lake and Lake Superior canals across Keweenaw Point, Michigan," but is locally known and referred to as the Portage Lake Ship Canals.

A full account of the history of this work and its purchase by the United States is given in the above Annual Report.

Maps of this waterway are given in the Annual Report for 1896, pages 2364 and 2365.

The full report of the Board of Engineers, constituted in compliance with the provisions of the river and harbor act of August 5, 1886, is given in the House Executive Document No. 105, Forty-ninth Congress, second session.

The project, as recommended by this Board and approved by the Chief of Engineers and the Secretary of War, provides for a 20-foot navigation through channels of 120 feet bottom width; for the extension of the Keweenaw entrance pier, 2,800 feet to 20 feet depth in Keweenaw Bay; for two breakwater piers, each about 2,740 feet long at the upper entrance, and for revetting the banks of all the artificial channels.

At the time of purchase by the United States there was a very poor 13-foot navigation; the channel was narrow and crooked with many sharp bends; it was poorly marked and lighted; the entrance piers were in a very bad condition; the revetments were rotten, or entirely gone, and there was a heavy tax on the commerce through the canals in the shape of a tonnage charge.

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With the $230,000 appropriated since the purchase, but before the appropriation of June 4, 1897, the entrance piers have been repaired and put in a good condition; the revetments most necessary for preserving the banks of the canal have been renewed with substantial timber structures; the channel has been deepened to give a good 16-foot navigation at low-water datum, with 70 feet width; many points have been cut away and several bends eased off, and Lily Pond, near the upper entrance, the passing place for vessels and their harbor of refuge, has been widened to 300 feet, and a strong bulkhead revetment, with mooring posts, has been provided. Tax on commerce has been removed by making it a free canal.

The amount expended to the close of the fiscal year, June 30, 1897, was $189,834.04. The money expended during the fiscal year ending June 30, 1898, has resulted in giving additional depth and in widening the channels.

The act of June 3, 1896, authorized continuous contracts for the improvement of this waterway to the amount of $1,065,000.

The sundry civil act of June 4, 1897, appropriated $350,000, and that of July 1, 1898, $450,000, making a total of $800,000 appropriated for these contracts, which are at present three in number, viz, that with Powell & Mitchell, of Marquette, Mich., mentioned in the last Annual Report, for 2,800 feet of pier extension at the Keweenaw entrance, and which will cost $120,000, including administration and contingencies; one with Porter Brothers, of Duluth, Minn., dated September 22, 1897, for the construction of 5,480 feet of breakwater piers at the upper entrance, to cost about $300,000, and to be completed by November 1, 1900, and one with the Racine Dredge Company, of Racine, Wis., dated March 16, 1898, for dredging 950,000 cubic yards of material, at a cost of about $80,000, and be completed by November 1, 1899. This makes $500,000 of contract liability. The contracts yet to be made are for widening the upper canal and other channels and excavating to 20 feet, and for the revetting of all the banks of the artificial channels.

The money now appropriated will carry on the work until the close of the season of 1900, so that it will not be necessary to appropriate anything in the next sundry civil bill. Under the Powell & Mitchell contract, up to June 30, 1898, some 200 feet of trench had been excavated, the foundation piles driven over this distance, one crib 100 feet in length sunk, and another crib 100 feet long was about completed at the dock.

Under the Porter Brothers' contract, 1,820 cords of stone had been placed in the riprap foundation, 415 foundation piles had been driven, and one crib 100 feet long had been about completed.

Under the Racine Dredge Company contract, 64,380 cubic yards of material had been excavated.

Besides the above, some repairs to the canal revetments, to the amount of $2,500 were made in the fall of 1897, and the dredging contract of C. S. Barker, in force at date of last Annual Report, was completed by the excavation of 227,000 cubic yards between June 30, 1897, and the close of navigation.

The record of vessels and tonnage herewith submitted shows the great amount of commerce using this waterway and how important a link it is in the chain of lake navigation.

During the last season, that of 1897, the commerce through this waterway has amounted to 1,526 vessels entering and departing, 986,740 registered tonnage, and 920,546 net freight tonnage, valued at $34,000,000, not including the local tug business, estimated at $450,000.

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OPERATING AND CARE.

Under authority of the river and harbor act of September 19, 1890, the Secretary of War allotted $8,300 for operating and care of canals and other works of navigation, to be applied to Portage Lake and Lake Superior canals, Michigan, for the fiscal year ending June 30, 1898.

The approved project for the expenditure of this allotment is to maintain the depth obtained by the work of improvement, with a width of 70 feet; to keep a record of the vessels and their tonnage using the canals; to exercise the necessary care in enforcing regulations for the use of the canals; to make frequent surveys to determine changes, and to check up work done in dredging; to guard against encroachments on the legally established harbor lines, and to perform other work incident to the operation and care of the canals. The amount allotted has been expended. An itemized statement is herewith submitted.

Owing to the faulty designs of the existing piers at the entrances and their failure to extend to a proper depth, more or less dredging has to be done each year to maintain the improved channels at these entrances.

A bar forms each year during the winter or early spring at the upper entrance, just outside the piers, and has to be removed by dredging. After removal at the opening of navigation no further trouble is experienced until the next spring. This will be continued until the piers have been extended into deep water. The usual dredging, amounting to 79,000 cubic yards, was done this spring at this entrance, and left it with a good 16-foot navigation.

The railroad and wagon road bridge across the Portage Lake, between Houghton and Hancock, continues an obstruction to navigation, by reason of the narrowness of the draw openings. A special report on this has been submitted, in which it is recommended that the owners (Houghton County) be required to remove the central pier entirely and substitute for the present drawspan one so constructed as to leave a clear opening to the full width of the present drawspans and center pier.

Location.—The Portage Lake ship canals constitute the waterway across Keweenaw Point, in the State of Michigan, from Keweenaw Bay to Lake Superior, there being about 25 miles of water route, consisting of 5½ miles of Portage River with its four cuts, 17 miles of Portage Lake, and 2¼ miles in the upper canal from the head of Portage Lake to Lake Superior. They are located in the district of Superior, Michigan, with Houghton, Mich., as the nearest port of entry. There are two regular United States light-houses with range lights at each entrance to the canals from the outside, and range lights at the head of Portage River and at the head of Portage Lake kept by the Light-House Department, and a number of intermediate stake lights and day beacons. The channels are also well buoyed.

The immediate charge of this waterway has continued under the management of Mr. G. A. Marr as assistant engineer and superintendent.

Money statements.

IMPROVEMENT.

July 1, 1897, balance unexpended	$390,165.96
Amount appropriated by sundry civil act approved July 1, 1898	450,000.00
	840,165.96
June 30, 1898, amount expended during fiscal year	49,418.32
July 1, 1898, balance unexpended	790,747.64
July 1, 1898, amount covered by uncompleted contracts	490,000.00
July 1, 1898, balance available	300,747.64
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	265,000.00

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OPERATING AND CARE OF CANALS.

July 1, 1897, amount allotted for fiscal year 1898	$8,300.00
June 30, 1898, amount expended during fiscal year	8,300.00
July 1, 1898, amount allotted for fiscal year 1899	8,300.00

Abstract of appropriations for improving waterway from Keweenaw Bay to Lake Superior, Michigan.

By act of Congress—	
Approved July 13, 1892	$50,000
Of August 18, 1894	130,000
Passed June 3, 1896	50,000
Approved June 4, 1897	350,000
Approved July 1, 1898	450,000
Total	1,030,000

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies.

Dredging	$168,000.00
Pier work, etc	69,252.36
Purchase of land	2,000.00
Total	239,252.36

Abstract of bids received in response to advertisement for building two breakwater piers at Lake Superior entrance to Portage Lake Ship Canals, Michigan, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, September 10, 1897.

No.	Name and address of bidder.	If superstructure and top two courses of cribs be of—				For stamp sand in place in work (per cubic yard).	Total, exclusive of stamp sand.	
		Sections 1, east and west (3,800 linear feet).		Sections 2, east and west (1,680 linear feet).				
		Norway pine (per linear foot).	White pine (per linear foot).	Norway pine (per linear foot).	White pine (per linear foot).		Norway pine.	White pine.
1	Porter Brothers, Duluth, Minn.	$63.55	$65.25	$23.49	$24.22	$0.70	$280,953.20	$288,639.60
2	Lydon & Drews Co., Chicago, Ill	70.00	71.35	26.00	26.50	.60	309,680.00	315,650.00
3	The L. P. and J. A. Smith Co., Cleveland, Ohio	72.39	73.39	28.97	29.97	.50	323,751.60	329,231.60
4	McArthur Brothers Co., Chicago, Ill	80.00	82.00	31.00	31.81	.85	356,080.00	365,040.80
5	Heldmaier & Neu, Chicago, Ill	.....	81.40	.....	32.75	.55	.....	364,340.00
6	Chicago Star Construction and Dredging Co., Chicago, Ill	66.50	70.00	30.25	31.00	.95	311,120.00	318,080.00
7	Joseph J. Churchyard, Buffalo, N. Y	79.50	81.25	31.80	32.60	.25	355,524.00	363,518.00
8	James L. Lipsett and Robert Gregg, Sault Ste. Marie, Mich	68.50	69.75	28.00	29.10	.38	307,340.00	313,938.00
9	L. V. Hoag, jr., Pittsburg, Pa	71.00	71.00	71.00	71.00	.99	389,080.00	389,080.00
10	Powell & Mitchell, Marquette, Mich	73.15	74.55	30.20	30.95	.75	328,706.00	335,286.00

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Abstract of bids received in response to public notice for repairing the revetment at the upper entrance of the Portage Lake Ship Canals, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, October 8, 1897.

No.	Name and address of bidder.	Stone in place, per cord.	Brush in place, per cord.	Timber in place, per 1,000 feet.
1	McCurdy Brothers, Houghton, Mich	$5	$6	$30

Letter bid, and acceptance. No formal contract. Work done by McCurdy Brothers, begun October 25, 1897, and completed November 20, 1897, amounting to about $2,500.

Abstract of bids received in response to advertisement for dredging in Portage Lake Ship Canals, Keweenaw Point, Michigan, opened at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, February 23, 1898.

No.	Name and address of bidder.	For dredging, per cubic yard (scow measurement).			For use of dredging plant per hour.	Total.
		Section 1, 50,000 cubic yards.	Section 2, 100,000 cubic yards.	Section 3, 800,000 cubic yards.		
		Cents.	*Cents.*	*Cents.*		
1	Carkin, Stickney & Cram, Detroit, Mich	17	20	9	$14	$100,500
2	The Lydon & Drews Co., Chicago, Ill	22	24	12	16	131,000
3	C. E. Mitchell & Co., Ludington, Mich	19	19	10	9	108,500
4	Green's Dredging Co., Chicago, Ill	15	25	12	10	123,500
5	The L. P. & J. A. Smith Co., Cleveland, Ohio	20	24	12	15	130,000
6	Arthur H. Vogel, Milwaukee, Wis	14	17	10	15	104,000
7	Adolph F. Bues, Milwaukee, Wis	10	12	8	10	81,000
8	James Pryor, Houghton, Mich	11	14	9½	10	95,500
9	Racine Dredge Co., Racine, Wis	10	14.9	7	9	75,900
10	Geo. H. Breymann, John B. Breymann, Toledo, Ohio	14	15	9	15	94,000
11	Green Bay Dredge and Pile Driving Co., Green Bay, Wis	20	12	8	10	86,000
12	Illinois Dredging Co., Chicago, Ill	12	20	9	15	96,000

LIST OF EXISTING CONTRACTS.

Contract for building 2,800 feet of pier extension at Keweenaw Bay entrance to Portage Lake Ship Canals, Michigan, with Powell & Mitchell, of Marquette, Mich., contract dated April 13, 1897, approved April 29, 1897; continuous contract; work begun May 1, 1898, and to be completed by November 1, 1900.

Contract for building two breakwater piers, each about 2,700 feet long at Lake Superior entrance to Portage Lake Ship Canals, Michigan, with Porter Brothers, of Duluth, Minn., dated September 22, 1897, approved October 13, 1897; work begun May 1, 1898, and to be completed by November 1, 1900.

Contract for about $80,000 worth of dredging in Portage Lake Ship Canals, Keweenaw Point, Michigan, with Racine Dredge Company, of Racine, Wis., dated March 16, 1898, approved April 20, 1898; work begun May 9, 1898, and to be completed by November 1, 1899.

COMMERCIAL STATISTICS.

Statistics of vessels passing through the canals during the calendar year 1897.

	Bound up.		Bound down.	
	Number.	Net tonnage.	Number.	Net tonnage.
Steam	726	533,839	386	205,672
Sail	283	172,879	131	74,250

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Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1897.

Bound up.	Net tons.	Bound down.	Net tons.
Coal	457,849	Copper	46,375
Manufactured iron	10,436	Flour	45,086
Salt	19,467	Wheat	2,100
Limestone	14,777	Pig iron	3,330
Copper	32,357	Iron ore	4,949
Miscellaneous merchandise	147,094	Lumber	145,985
		Miscellaneous merchandise	10,841
Total	661,980	Total	258,566
Passengers	17,495	Passengers	17,441

Recapitulation.

	Bound up.				Bound down.			
	1897.		1896.		1897.		1896.	
	Total.	Upper canal.	Total.	Upper canal.	Total.	Upper canal.	Total.	Upper canal.
Number of vessels	1,009	696	1,166	818	517	284	606	334
Net tonnage	706,718	537,654	709,475	571,816	280,022	153,049	314,504	191,814
Freight ..... tons	661,980	300,628	582,132	238,756	258,566	193,862	336,792	260,014
Passengers ..... number	17,495	12,726	20,991	16,516	17,441	12,489	20,361	16,055

Statistics of tugs passing through the canals during the year 1897.

	Bound up.	Bound down.
Trips ..... number	706	699
Net tonnage ..... tons	19,451	19,184
Vessels ..... number	55	17
Scows ..... do	274	272
Rafts ..... do	92	127
Booms ..... do	58	89
Logs ..... M feet	11,845	14,405
Lumber ..... do	4,097	756
Timber ..... do	6,850	33
Shingles ..... do	977	311
Lath ..... do	863	1,150
Cordwood ..... cords	2,264	280
Coal ..... tons	655	100
Building stone ..... do	17,482	.....
Miscellaneous merchandise ..... do	2,115	303
Charcoal ..... bushels	.....	2,665
Passengers ..... number	.....	6

Local business of tugs in Portage Lake during the year 1897.

Bound up.	Total.	Bound down.	Total.
Trips ..... number	683	Trips ..... number	667
Net tonnage ..... tons	12,645	Net tonnage ..... tons	12,712
Scows ..... number	623	Scows ..... number	776
Rafts ..... do	6	Rafts ..... do	16
Booms ..... do	11	Booms ..... do	7
Logs ..... M feet	175	Logs ..... M feet	1,276
Lumber ..... do	4,194	Lumber ..... do	1,702
Timber ..... do	1,393	Timber ..... do	1,085
Shingles ..... do	50	Brick ..... M	125
Piles ..... number	32	Piles ..... number	10
Railroad ties ..... do	10,700	Railroad ties ..... do	1,800
Poles ..... cords	420	Charcoal ..... bushels	186,500
Cordwood ..... do	8,088	Cordwood ..... cords	9,874
Hay ..... tons	120	Poles ..... do	90
Sand ..... do	120	Copper ..... tons	1,093
Scrap iron ..... do	250	Hay ..... do	105
Miscellaneous merchandise ..... do	145	Clay ..... do	1,000
Passengers ..... number	621	Miscellaneous merchandise ..... do	597
		Passengers ..... number	650

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Statistics of vessels passing through the upper canal (Portage Lake ship canals) for the year 1897.

	Steam vessels.		Sailing vessels.		Cargo (net tons).	Passengers.
	Number.	Net tonnage.	Number.	Net tonnage.		
Bound up	530	442,032	166	95,622	800,623	12,726
Bound down	229	127,528	55	25,526	193,862	12,489

Recapitulation (Portage Lake ship canals).

Bound up and down.	1892.	1893.	1894.	1895.	1896.	1897.	Increase (+) or decrease (—) 1897 over 1896.
Total number of vessels	1,470	1,408	1,724	1,731	1,774	1,526	— 248
Total net tonnage	665,063	669,510	860,618	956,779	1,023,979	986,740	— 37,239
Total freight, tons	496,288	532,628	754,973	831,962	918,924	920,546	+ 1,622
Total passengers, number	30,093	27,064	32,636	24,809	41,262	34,936	— 6,326

Items.	Price per unit.	Total valuation.	
		1896.	1897.
Coal, net tons	$3.65	$1,456,218.60	$1,600,904.60
Flour, barrels	5.00	2,960,450.55	2,253,560.00
Wheat, bushels	.90	169,072.50	54,009.09
Grain, do	.50	39,207.87	2,000.00
Manufactured iron, net tons	50.00	708,600.00	521,300.00
Pig iron, do	13.50	108,432.00	44,955.00
Iron ore, do	3.25	54,453.75	16,064.25
Salt, barrels	.75	74,859.75	102,202.50
Copper, net tons	220.00	14,894,600.00	17,321,040.00
Lumber, M feet B. M.	12.50	1,293,800.00	1,238,912.50
Logs, do	9.00	852,035.00	236,250.00
Building stone, net tons	10.00	146,740.00	174,820.00
Unclassified freight, do	60.00	7,646,820.00	10,477,740.00
Total		29,953,787.02	34,044,268.85

The following tables are submitted, giving the principal lines of vessels using these canals during the season of 1897:

Lake Michigan and Lake Superior Transportation Company, Chicago, Ill	5
The Erie and Western Transportation Company (Anchor Line), Buffalo, N. Y	17
The Western Transit Company, Buffalo, N. Y	12
The Union Transit Company, Buffalo, N. Y	7
The Jenks Shipbuilding Company, Port Huron, Mich	3
The Whitney Transportation Company, Detroit, Mich	8
The Vulcan Transportation Company, Detroit, Mich	4
The Hope Transportation Company, Detroit, Mich	3

There have been but slight changes in the above lines, and the following table gives the principal lines for the season of 1898:

Lake Michigan and Lake Superior Transportation Company, Chicago, Ill	5
The Erie and Western Transportation Company (Anchor Line), Buffalo, N. Y	17
The Western Transit Company, Buffalo, N. Y	12
The Union Transit Company, Buffalo, N. Y	6
The Jenks Shipbuilding Company, Port Huron, Mich	3
The Whitney Transportation Company, Detroit, Mich	8
The Vulcan Transportation Company, Detroit Mich	4
The Hope Transportation Company, Detroit, Mich	3
Northern Steamship Company, Buffalo, N. Y	8
Marine Transit Company, Marine City, Mich	4
C. H. Bradley, Bay City, Mich	4

The above lists give merely the principal regular transportation lines that are using these canals. There are many vessels belonging to individuals, many of them large steel steamers and barges, and barges with vessels in tow, that are using these canals regularly. There is also the usual local business of tugs towing vessels, rafts, scows loaded with wood, lumber, stone, etc.

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation (indefinite), act of July 5, 1884, applied to Portage Lake and Lake Superior canals, during fiscal year 1898.

Date.	No. of voucher.	Name.	Designation.	Amount.
1897.				
July 31	49	J. H. Rice	Rent	$19.00
31	50	Joseph Slock	Storage	2.00
31	(pt.) 51	Pay roll (pt.)	Services	204.00
31	54	Sam S. Robinson	Tug hire	86.25
Aug. 31	57	Joseph Slock	Storage	2.00
31	58	J. H. Rice	Rent	19.00
31	(pt.) 61	Pay roll (pt.)	Services	216.00
Sept. 3	1	Sam S. Robinson	Tug hire	97.50
30	52	Joseph Slock	Storage	2.00
30	53	J. H. Rice	Rent	19.00
30	(pt.) 54	Pay roll (pt.)	Services	205.00
Oct. 2	8	Sam S. Robinson	Tug hire	72.00
31	64	J. H. Rice	Rent	19.00
31	65	Joseph Slock	Storage	2.00
31	(pt.) 66	Pay roll (pt.)	Services	212.00
Nov. 1	1	Sam S. Robinson	Tug hire	114.75
30	58	Joseph Slock	Storage	2.00
30	59	J. H. Rice	Rent	19.00
30	(pt.) 60	Pay roll (pt.)	Services	209.50
Dec. 31	28	Joseph Slock	Storage	2.00
31	29	J. H. Rice	Rent	19.00
31	(pt.) 30	Pay roll (pt)	Services	132.00
1898.				
Jan. 31	(pt.) 25	Pay roll (pt.)	Services	132.00
31	26	J. H. Rice	Rent	19.00
31	27	Joseph Slock	Storage	2.00
Feb. 5	(pt.) 6	Chamberlain & Taylor	Stationery (pt.)	23.72
28	27	J. H. Rice	Rent	19.00
28	28	Joseph Slock	Storage	2.00
28	(pt.) 29	Pay roll (pt.)	Services	132.00
Mar. 31	(pt.) 51	.....do.....	.....do.....	132.00
31	52	Joseph Slock	Storage	2.00
31	53	J. H. Rice	Rent	19.00
Apr. 23	22	John L. Penrose	Record book	8.95
30	49	Joseph Slock	Storage	2.00
30	50	J. H. Rice	Rent	19.00
30	(pt.) 52	Pay roll (pt.)	Services	171.59
May 16	(pt.) 40	J. L. Thwing	Vessel books (pt.)	70.00
31	58	Joseph Slock	Storage	2.00
31	59	J. H. Rice	Rent	19.00
31	(pt.) 63	Pay roll (pt.)	Services	480.67
June 4	(pt.) 12	Harvey C. Beeson	Books (pt.)	5.00
6	14	Racine Dredge Co	Dredging	2,805.22
14	(pt.) 32	Louis Hennes	Supplies (pt)	12.85
21	37	Racine Dredge Co	Dredging	2,199.88
30	(pt.) 59	Pay roll (pt.)	Services	306.00
30	55	J. H. Rice	Rent	19.00
30	56	Joseph Slock	Storage	2.00
30	54	James R. Dee	Telephone	18.00
30	(pt.) 42	Chamberlain & Taylor	Stationery (pt.)	1.21
		Total		8,300.00

Summary of expenses made from appropriation for operating and care of canals and other works of navigation (indefinite), act of July 5, 1884, applied to Portage Lake and Lake Superior canals, during fiscal year 1898.

Month.	Office expense.	Dredging.	Tug hire.	Supplies.	Field service.	Miscellaneous.	Total.
1897.							
July	$69.00		$86.25		$154.00	$2.00	$311.25
August	69.00				166.00	2.00	237.00
September	69.00		97.50		155.00	2.00	323.50
October	69.00		72.00		162.00	2.00	305.00
November	70.00		114.75		158.50	2.00	345.25
December	71.00				80.00	2.00	153.00
1898.							
January	71.00				80.00	2.00	153.00
February	94.72				80.00	2.00	176.72
March	71.00				80.00	2.00	153.00
April	79.95				119.50	2.00	201.45
May	191.00	$2,805.22			378.67	2.00	3,376.89
June	122.21	2,199.88		$12.85	204.00	25.00	2,563.94
Total	1,046.88	5,005.10	310.50	12.85	1,817.67	47.00	8,300.00

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IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

Originally this harbor was entirely unprotected from northeast storms.

Projects were adopted in 1868 and 1888 for the erection of a breakwater composed of timber cribs ballasted with rock, extending from the shore into the bay a distance of 3,000 feet. This breakwater was completed, practically as proposed, in 1894, at a total cost of $469,732.44, including repairs.

Owing to the general decay of a large portion of the original superstructure, and the certainty that the whole of it would have to be renewed every twenty or twenty-five years, a project for a concrete superstructure for the whole breakwater was approved February 27, 1890. This project was estimated to cost $232,936.71.

Work on this was begun in the spring of 1895, and 860 linear feet of it completed by the close of navigation in 1896. Of this, 390 linear feet was built during the fiscal year 1896–97. (For detailed description of this work, with drawings, cost, photographic views, etc., see the Annual Reports (pp. 2365–2385), 1896 and (pp. 2615–2638) 1897.)

During the past fiscal year 164 footing blocks have been constructed, making 204 in all, of which 28 have been placed in the work, and 140 linear feet of the main work has been completed, making 1,000 linear feet. These footing blocks were fully described and illustrated in the last Annual Report. Their admirable adaptation to the purpose for which they were intended, as demonstrated in the 140 feet of new work, fully justifies their construction. Mr. Clarence Coleman continued in charge of this work until the funds were practically exhausted, May 1, 1898, and he was then transferred to Duluth to take immediate charge of the concrete work there. Attention is invited to his report herewith, which contains much of professional interest regarding concrete and its ingredients.

The amount expended on this harbor up to June 30, 1897, was $525,362.41. The results have been the complete protection of the ore, coal, lumber, and commercial docks from storms.

The results due to the expenditure of $6,180.96 during the fiscal year ending June 30, 1898, have been to make permanent 140 feet more of the breakwater which affords this protection, thus dispensing with renewals every twenty years.

Owing to the shortness of the working season during which concrete can be laid safely—only five months—it is very desirable to have an appropriation large enough to keep up work with a full force throughout at least two working seasons.

The work has been carried on by hired labor, the material having been purchased by contract after due advertisement. The growth of the commerce of this port was steady and quite marked up to 1892, when, owing to the general business depression, it showed a decline. It is now increasing, however.

During the fiscal year ending June 30, 1872, there were 780 arrivals and clearances of vessels, with a registered tonnage of 370,000 tons.

In 1897 there were 1,447 arrivals and clearances, with a registered tonnage of 1,577,111 tons. In twenty years the commerce of the port has amounted to at least $80,000,000.

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Money statement.

July 1, 1897, balance unexpended	$8,195.35
June 30, 1898, amount expended during fiscal year	6,180.96
July 1, 1898, balance unexpended	2,014.39
Amount (estimated) required for completion of existing project	198,936.71
Amount that can be profitably expended in fiscal year ending June 30, 1900	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Abstract of appropriations for improving harbor at Marquette, Mich.

By act of Congress—	
Approved March 2, 1867, (allotment)	$85,000.00
Approved April 10, 1869, (allotment)	26,730.00
Approved July 11, 1870	25,000.00
Approved March 3, 1871	60,000.00
Approved June 10, 1872	50,000.00
Approved March 3, 1873	15,000.00
Approved June 23, 1874	15,000.00
Approved March 3, 1875	15,000.00
Approved June 18, 1878	2,000.00
Approved August 14, 1878	2,000.00
Approved March 3, 1879	1,500.00
Approved June 14, 1880	1,000.00
By act of Congress—	
Passed August 2, 1882	$16,000.00
Approved July 5, 1884	5,000.00
Approved August 5, 1886	10,000.00
Of August 11, 1888	25,000.00
Approved September 19, 1890	40,000.00
Approved July 13, 1892	80,000.00
Of August 18, 1894	30,000.00
Passed June 3, 1896	29,000.00
Deposited in United States Treasury January 28, 1896	327.76
Total	533,557.76

Name of harbor, Marquette Harbor, Michigan. Collection district, Marquette, Mich. Nearest light-house, Marquette, Mich.

COMMERCIAL STATISTICS.

Arrivals and clearances, 1893–1897.

	Arrivals.	Clearances.	Tonnage.
1893	661	661	594,900
1894 (steam, 660; sail, 256)	916	916	900,306
1895 (steam, 543; sail, 254)	797	797	915,800
1896 (steam, 692; sail, 340)	1,032	1,032	1,586,184
1897 (steam, 482; sail, 249)	731	716	1,577,111

Principal articles of export and import.

Exports.	Tons.	Imports.	Tons.
Iron ore	2,282,558	Coal	140,965
Pig iron	9,380	Oil	
Lumber	89,015	General merchandise	6,800
General merchandise	800	Total	147,765
Total	2,381,753		

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Vessel tonnage.

Year.	Tonnage.	Average tonnage.
1897	1,577,111	1,090
1896	1,586,184	768
Increase or decrease	—9,073	+322

Comparative statement of receipts and shipments.

	Tons.
1896	1,832,061
1897	2,529,518

Arrivals and clearances of vessels, 1892–1897.

Year.	Arrivals.	Clearances.	Tonnage.	Year.	Arrivals.	Clearances.	Tonnage.
1892	782	788	1,474,002	1895	797	797	915,800
1893	661	661	594,900	1896	1,032	1,032	1,586,184
1894	916	916	900,306	1897	731	716	1,577,111

REPORT OF MR. CLARENCE COLEMAN, ASSISTANT ENGINEER.

MARQUETTE, MICH., *June 20, 1898.*

MAJOR: I have the honor to submit herewith the following report of operations in connection with the construction of the concrete superstructure to the United States breakwater at Marquette, Mich., from the 1st of December, 1896, to the 30th of November, 1897, inclusive dates. The work of constructing 40 footing blocks during the winter of 1896–97 has been previously reported in a supplemental report. (Report of Chief of Engineers, U. S. A., 1897, Appendix G G, page 2642.) Owing to the limited amount of the unexpended appropriation for improving Marquette Harbor, I was instructed by you to complete 140 linear feet of the concrete superstructure and to construct a sufficient number of the concrete footing blocks to complete 1,000 linear feet of the concrete foundation for the monolithic blocks. With this in view the work of the season proper was commenced on May 12, 1897, with the removal of the timber superstructure on the lake front for a width of 10 feet, measured transversely to the axis of the breakwater, and 144 feet in length. The timber and stone were removed to a depth of 1 foot below L. W. D., and the foundation intended to support the footing blocks prepared as described in the Report of the Chief of Engineers, U. S. A., 1897, Appendix G G, page 2626.

The remaining 20 feet width of the timber superstructure was temporarily left in place and utilized as a platform, from which the movable derrick was worked in setting the footing blocks. The work of setting 28 footing blocks was completed June 15, being somewhat retarded by rough water, which very frequently prevented the prosecution of the work.

The balance of the timber and stone superstructure was removed from the 16th to the 24th of June, inclusive dates. The work of constructing the Portland cement subaqueous concrete foundation was performed from the 18th to the 25th of June, inclusive dates, and the work of molding the concrete monoliths in place was commenced on the 29th of June and completed on the 16th of July, one block being molded on each working day. The same plans and methods as those described in the Report of the Chief of Engineers, U. S. A., 1897, Appendix G G, page 2620, were continued in molding the monolithic blocks, and no change has been made in the proportions of the cement, sand, stone, and water from the inception of the work in 1895. Preparatory to the work of the season, the slope pieces of the concrete forms were lined with No. 8 American gauge sheet steel, and, as expected, the results were very satisfactory. Very smooth surfaces were produced on the slopes of the concrete and the work of the molders was greatly facilitated on account of the comparative ease with which the concrete was compacted under the slope pieces of the molds. The steel effectually prevented the aggressive friction of the sharp particles of broken stone on the wooden surfaces of the molds, thus increasing the life of the molds and decreasing the cost of molding the concrete. Immediately upon the com-

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pletion of the large monoliths, the work of molding a sufficient number of footing blocks to complete 1,000 linear feet of the foundation was commenced. An additional platform for molding, with a capacity for 36 blocks, was constructed, along with new storage tracks of sufficient capacity to hold the proposed blocks. The actual work of molding was begun on the 24th of July and completed on the 28th of October, two blocks being constructed on each working day during this period. A force consisting of one master laborer and from four to five laborers was employed on this work; a part of the time of an overseer and carpenter was also devoted to this construction. Samples of the concrete as mixed upon the mixing platform were taken from each day's work and made into briquets and cubes for testing. The results obtained are shown in tables No. 6 and No. 7, accompanying this report.

The molds were generally removed from the blocks after twenty-four hours, though great care had to be exercised in this operation, especially during the latter part of the work, with lower temperature prevailing.

The blocks were generally removed from the platforms after fifteen days to give space for molding other blocks, but in a few cases they were handled when nine days old. The amount of cement used was decreased from 20 pounds per cubic foot of stone to 16 pounds per cubic foot in blocks 68 to 204, inclusive. A number of tests made with concrete containing the smaller proportion of cement seemed to show an excess of strength and hardness for the purposes for which they were intended.

It will be noted in tables Nos. 6 and 7 that an experiment was made with the use of natural cement in blocks 66 and 67. The results obtained by this experiment, coupled with those obtained in the cement-testing laboratory, seem to indicate that the natural cement used fulfills all the conditions required except the rapid acquisition of strength. With temperature very favorable, say averaging 60° F., such blocks made with natural cement could be safely handled after twenty-eight days. It will be readily perceived that this would require much additional platform capacity, which the restricted amount of ground at Marquette absolutely prohibited. A total of 204 footing blocks have been constructed, 28 of which have been placed in the work. The remaining 176 blocks are on the storage tracks in the yard and a few are in the concrete house. Under all of the varying conditions to which they have been subjected, whether in the work or stored, they have remained in very perfect condition. Those which were placed in the work during the spring of 1897 have been subjected to the influence of ice grind and pressure without showing any perceptible wear or deterioration. The change effected by the introduction of these footing blocks in the construction of the concrete superstructure has more than fulfilled the measure of what was expected from their use in greatly improving the construction and facilitating the work and reducing the cost of the subaqueous foundation. While the cost per cubic yard for this work has been increased, the cost per linear foot has been diminished through greatly decreasing the volume of concrete required for the foundation.

During the season of 1897 three brands of cement were used in the work. The large monoliths of the superstructure were constructed entirely with the Keystone brand of Milwaukee natural cement. That part of the subaqueous foundation which was built in place was constructed exclusively with Lagerdorfer Portland cement, Eiffel Tower brand. In the construction of the footing blocks the same brand of Lagerdorfer cement was used, with the exception of nine blocks, which were made with Empire Portland cement, and two experimental blocks made with Milwaukee natural cement.

A complete record of the meteorological conditions prevailing during the construction of all the various blocks has been kept with a view of determining, if possible, the effect of such variations in the practical construction of concrete. Sheet No. 1,* accompanying this report, is a plan showing the concrete superstructure as completed on July 16, 1897. Plate No. 100* is a view of the superstructure as completed on same date. Plates Nos. 132,* 133,* and 135* are illustrations of a condition which occurs occasionally during the winter, and which generally reaches its maximum effect with a southeast wind and an ice field of moderate area; when the ice is slowly forced against the breakwater, piling up and falling back into the lake until a mass of broken ice, resting on the bottom of the lake and reaching higher than the summit of the concrete superstructure, is formed. In a few instances such tremendous pressure has been noted as caused the crest of the ice ridge to break and fall over on the harbor side of the breakwater. This condition is greatly assisted by the outline of the shore at this place, the promontory known as Lighthouse Point serving to check the movement of ice fields moving in a northwesterly direction, and causing extremes of lateral pressure along the easterly side of the breakwater. No. 132* is from a point about 700 feet distant from shore, looking northward, the concrete superstructure being covered by the solid ice sheet shown

*Not for publication, unless thought specially desirable.—C. B. S.

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in the left of the picture. No. 133* is a general view of the pressure ridge, taken from a point 300 feet distant from shore, looking south, and the concrete superstructure is covered by the ice sheet shown in the right of the picture. No. 135* is another view, looking south, and was taken from a position on the pressure ridge about 400 feet distant from shore. No. 122* is a short section of the concrete superstructure, as seen from the harbor side on February 1, 1898, illustrative of winter conditions. Table No. 1 shows the cost of material and labor, with superintendence, for the time actually expended on the various classes of concrete.

CEMENT TESTING.

The methods employed in this work have been described in Report of Chief of Engineers, U. S. A., 1897, Appendix G G, page 2623.

Tables Nos. 2, 3, and 4 show the characteristics of natural Milwaukee cement under the regular tests to which this cement has been subjected.

Table No. 5 shows the characteristics of the materials used in the actual construction of the concrete superstructure to the breakwater. The samples from which these tests were made were taken from the mixing platform on the work, and only such stones were removed as were too large to admit of being placed in the briquet molds. The briquets were exceedingly rough in appearance, and the results obtained, as shown in the column a^1, showing the percentage of increase in tensile strength, were very satisfactory.

Tables Nos. 6 and 7 show the characteristics of the Portland cement concrete used in the construction of the footing blocks, with the relations of the materials used by weight and volume, as far as can be expressed, with the thermic conditions prevailing during the work, as also the cost for each item of material used in composing 1 cubic yard of concrete, with the total cost per cubic yard for materials. In the same table similar data and results are given for the concrete composing two footing blocks which were constructed with natural cement (Keystone Milwaukee). Under column c^1 the percentage of absorption for the various mixtures with the different cements is given. The selection of the samples from which the tests shown in tables 6 and 7 were made consisted in taking from the mixing platform on each day a sufficient amount of the concrete and molding it by the ordinary methods into briquets and cubes. The briquets were broken at the ages shown in the tables and the cubes were tested for absorption. It is believed that these tables of concrete tests will prove of some value as expressing actual conditions in practical work, and no attempt has been made to subject the concrete under test to any other treatment than it received at the hands of the laborers on the work.

Table No. 8 shows the results of tests made with Portland cement mortar proportioned in such a manner as to equal in cost the mortar of natural cement used in the construction of the large monoliths of the superstructure to the breakwater. The comparison of the natural cement mortar has been made with four Portland cements.

Table No. 9 shows the effect of a small variation in the percentage of water used with the same brand of Portland cement.

Table No. 10 shows the results obtained with Empire Portland cement used with three parts of sand. A small amount of this cement has been used in the construction of the footing blocks.

The results embodied in Tables Nos. 11 and 12 were made to determine the relative value of sharp angular sands and broken stone as compared with waterworn sand and pebbles.

The table explains how these sands and pebbles were graded to agree with each other as to fineness. The results seem to indicate that the waterworn or smooth sand and pebbles are certainly as good for constructive purposes as the sharp and angular sand and broken stone. The manner of selecting the materials for this test was rather against the waterworn pebbles and sand, for the reason that in the case of the trap and quartzite stone and sand the geological origin was undoubted, and hence the soundness of the rock was well assured. In the case of the pebbles and sand obtained from the lake a very considerable proportion of the particles consisted of sandstone or slate. From a number of tests made with the lake pebbles these weaker particles were found to represent 6.26 per cent of the weight of the pebbles, and it is assumed that the same conditions existed with the lake sand. To better determine the influence of these weaker particles in the test for tensile strength, as shown in Table No. 11, column i, references 10, 11, and 12, the soft particles were removed from the pebbles only, with the result shown in that table. It is believed that could the sand have been treated in the same manner the results would have been still further improved. During the year the total number of briquets made amounted to 5,470. Five thousand three hundred and fifty briquets were broken,

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CONSTRUCTION OF THE CONCRETE WATER, OCTOBER 1, 1897.

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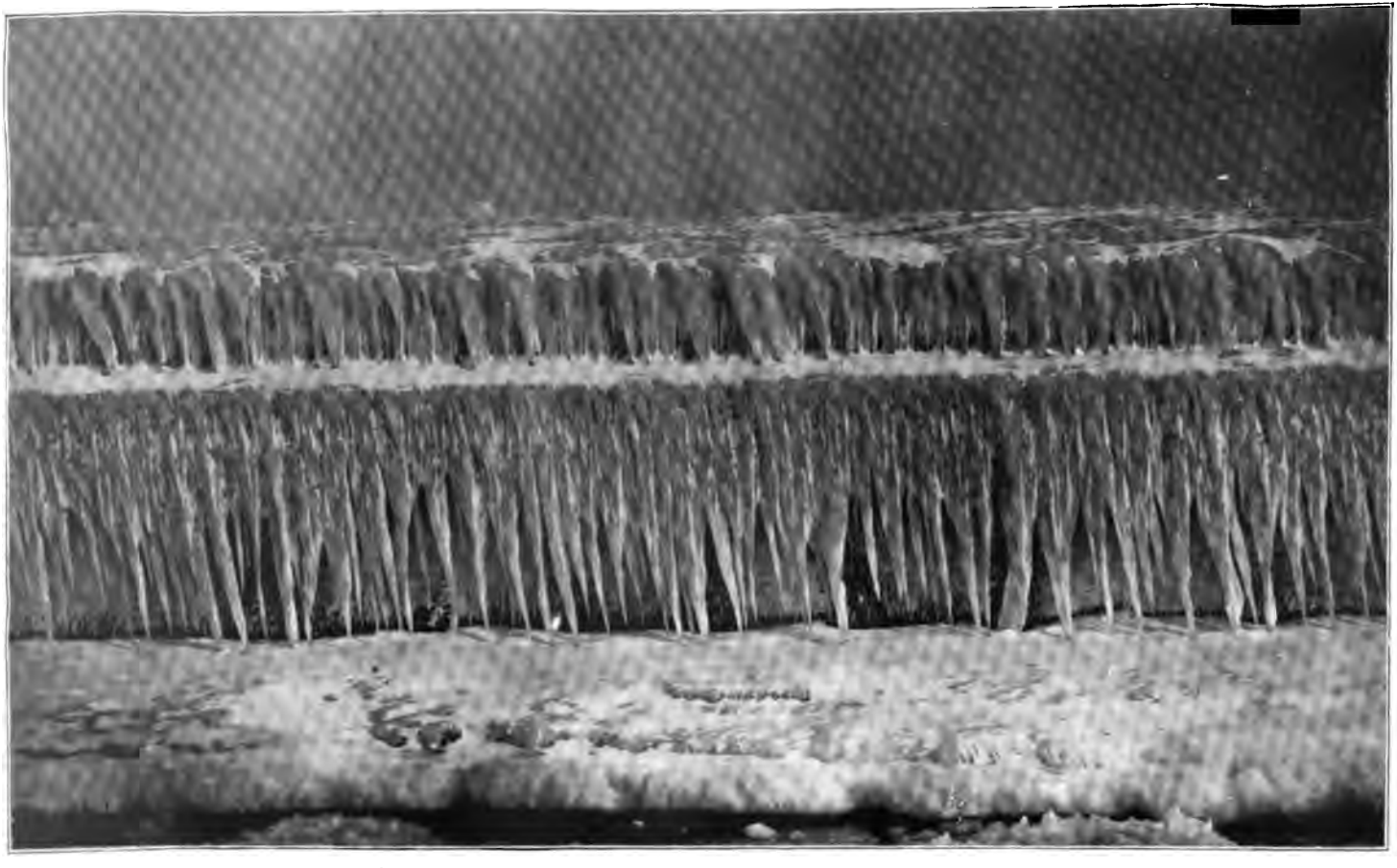

CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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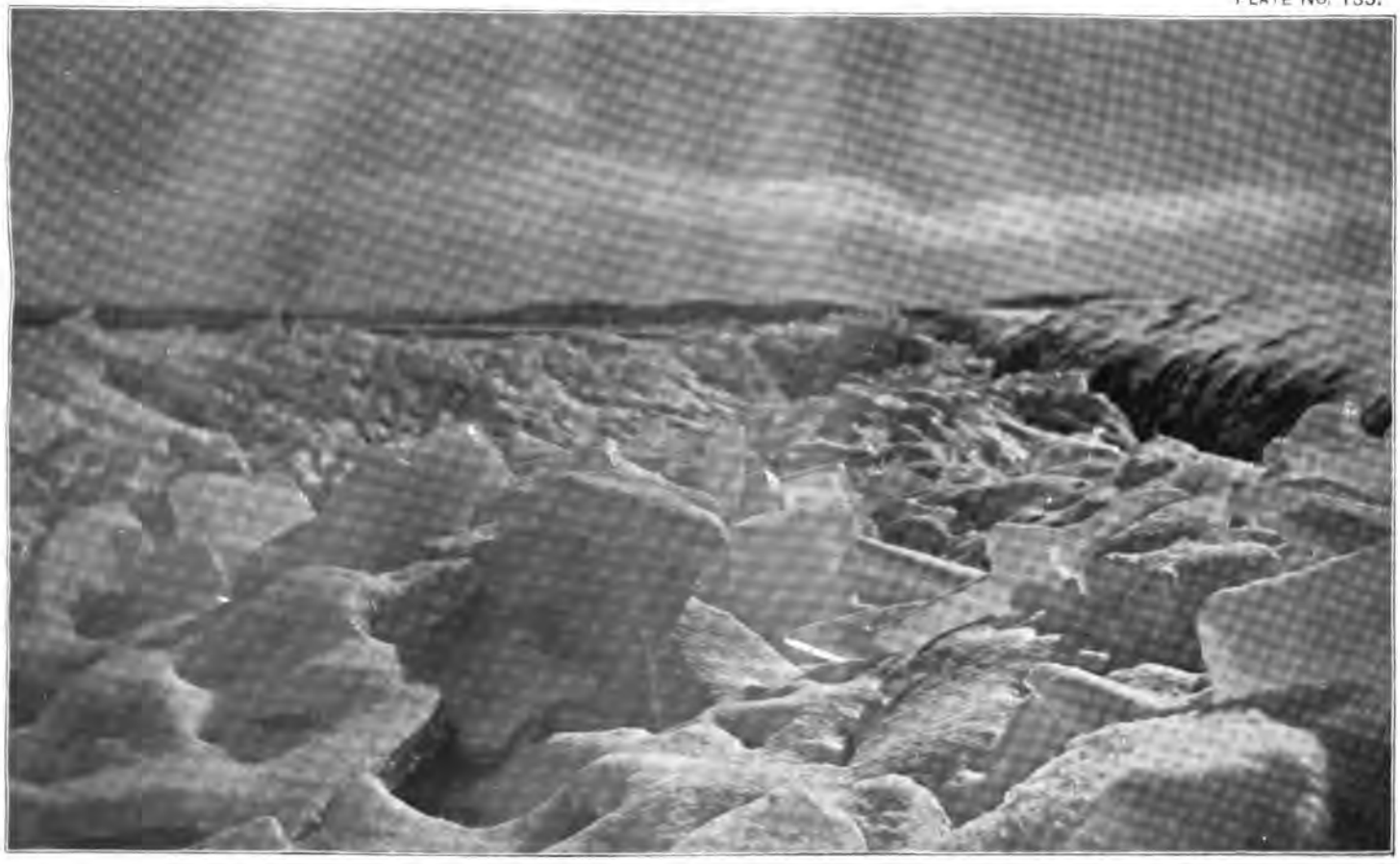

CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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and there are 2,265 briquets in the tanks for future dates. As during the two preceding years, the entire work has been performed by hired labor. No accidents involving injury to employees or loss of property have occurred.

Very respectfully,

CLARENCE COLEMAN,
Assistant Engineer.

Maj. CLINTON B. SEARS,
Corps of Engineers, U. S. A.

TABLE No. 1.—*Concrete superstructure to breakwater at Marquette, Mich.*

QUANTITY AND COST OF MATERIALS AND COST OF LABOR AND SUPERINTENDENCE FOR COMPOSING CONCRETE IN PLACE, 1897.

Kind of work.	Portland cement.		Natural cement.		Broken stone.		Stone screenings.	
	Barrels.	Cost.	Barrels.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Monolithic concrete blocks	.....	.....	881	$1,018.15	503.5	$880.77	25	$37.50
Subaqueous concrete foundation	132	$363.00	.....	.....	126.0	207.90	.....	.....
Concrete footing	35	96.25	.....	.....	28.0	46.20	.....	.....
Concrete footing blocks	537	1,476.75	9	10.35	121.0	199.65	325	357.50
Total labor and materials	704	1,936.00	890	1,023.50	778.5	1,284.52	350	385.00

Kind of work.	Sand.		Rubble stone.		Iron.		Burlap.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Pounds.	Cost.	Yards.	Cost.
Monolithic concrete blocks	251.75	$85.59	118.66	$0.00	10.15	$15.22	.....	.....
Subaqueous concrete foundation	59.00	20.06	.....	.....	.....	.....	2,000	$95.00
Concrete footing	14.00	4.76	.....	.....	.....	.....	.....	.....
Concrete footing blocks	223.00	80.28	.....	.....	.....	.....	.....	.....
Total labor and materials	547.75	190.64	118.66	0.00	10.15	15.22	2,000	95.00

Kind of work.	Tarred paper.		Gas pipe.		Twine and needles.	Tacks.		Total cost of material.
	Pounds.	Cost.	Linear feet.	Cost.		Packages.	Cost.	
Monolithic concrete blocks	875	$4.02	56	$197	.....	12	$0.40	$1,978.62
Subaqueous concrete foundation	.....	.....	.....	.....	$6.20	.....	.....	692.16
Concrete footing	.....	.....	.....	.....	.....	.....	.....	147.21
Concrete footing blocks	.....	.....	.....	.....	.....	.....	.....	2,124.48
Total labor and materials	875	4.02	56	197	6.20	12	.40	4,942.47

Kind of work.	Superintendence and labor.			Concrete in place.	
	Mixing.	Depositing.	Total cost.	Cubic yards.	Cost per cubic yard.
Monolithic concrete blocks	$410.05	$365.47	$775.52	647.16	$4.255
Subaqueous concrete foundation	102.65	162.87	265.52	126.00	7.601
Concrete footing	.....	.....	145.83	28.00	10.426
Concrete footing blocks	.....	.....	1,342.61	452.88	7.632
Total labor and materials	512.70	528.34	2,529.48	1,254.04	.....

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Quantities and values of materials on hand November 30, 1897.

Designation.	Quantity.	Cost per unit.	Value.
Portland cement ..... barrels..	11.72	$2.75	$32.22
Natural cement ..... do....	262	1.15	301.30
Broken stone ..... cubic yards..	41.5	1.65	68.48
Sand ..... do....	126	.34	42.84
Stone screenings ..... do....	22.8	1.10	25.08
Burlap ..... yards..	2,000	.04½	95.00
Assorted iron	.....	.....	36.93
Small tools, etc	.....	.....	536.50
Rubber boots ..... pairs..	20	.....	87.00
Total value of material on hand	.....	.....	1,225.36

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TABLE No. 2.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.

Reference.	No. of barrel.	Cement. Kind.	Time of setting. To bear ¼-inch wire, weighing ¼ pound.	Time of setting. To bear ¼-inch wire, weighing 1 pound.	Fineness. Per cent passing No. 50.	Fineness. Per cent passing No. 100.	Sand. Kind.	Sand. Fineness. Per cent passing No. 10.	Sand. Fineness. Per cent passing No. 20.	Sand. Fineness. Per cent passing No. 30.	Sand. Fineness. Per cent passing No. 50.	Sand. Parts to one of cement.	Water as per cent of dry ingredients.	Date made.	Age.	Tensile strength. Mean.	Tensile strength. Highest.	Tensile strength. Lowest.	Tensile strength. Number averaged.	Percentage of increase in tensile strength.	Temperature. Air of mixing room.	Temperature. Water in tank.	Temperature. Water for mixing.	Temperature. Dry ingredients.	Temperature. Molder.
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
1	2700	Natural	Min. 56	Min. 74	96.00	87.42	Lake	100	93.7	52.55	11.30	3	12.50	1896.		127	139	117	5		73	63	65	67	63
2	2700	do	55	80	94.42	80.00	do	100	93.7	52.55	11.30	3	12.50	10.3	7 days	127	144	125	5		71	63	65	66	63
3	2800	do	46	77	94.90	81.29	do	100	93.7	52.55	11.30	3	12.50	10.3	do	79	97	72	5		68	63	65	63	63
4	2800	do	57	77	94.80	82.64	do	100	93.7	52.55	11.30	3	12.50	10.5	do	69	76	60	5		68	63	67	63	63
5	2900	do	36	74	96.49	86.64	do	100	93.7	52.55	11.30	3	12.50	10.5	do	74	79	68	5		68	63	65	64	63
6	2900	do	50	74	96.19	84.26	do	100	93.7	52.55	11.30	3	12.50	10.5	do	98	103	96	5		70	63	65	65	63
7	3000	do	40	74	95.94	81.30	do	100	93.7	52.55	11.30	3	12.50	10.6	do	79	88	76	5		71	63	65	64	63
8	3000	do	51	82	96.23	82.96	do	100	93.7	52.55	11.30	3	12.50	10.7	do	98	121	76	5		69	63	65	63	63
9	3100	do	50	76	96.22	80.40	do	100	93.7	52.55	11.30	3	12.50	10.7	do	91	106	76	5		68	63	65	63	63
10	3100	do	39	76	96.26	80.31	do	100	93.7	52.55	11.30	3	12.50	10.8	do	131	139	128	5		68	63	65	63	63
11	3200	do	43	86	94.90	84.12	do	100	93.7	52.55	11.30	3	12.50	10.8	do	121	134	108	5		68	63	65	63	63
12	3200	do	55	80	97.16	80.10	do	100	93.7	52.55	11.30	3	12.50	10.9	do	91	108	76	5		72	63	65	64	63
13	3300	do	43	73	96.30	79.87	do	100	93.7	52.55	11.30	3	12.50	10.17	do	68	72	67	5		69	63	65	64	63
14	3300	do	44	73	94.83	79.20	do	100	93.7	52.55	11.30	3	12.50	10.17	do	66	72	61	5		68	63	65	64	63
15	3400	do	53	79	93.80	81.60	do	100	93.7	52.55	11.30	3	12.50	10.20	do	73	77	68	4		71	63	65	66	63
16	3400	do	46	75	94.60	82.33	do	100	93.7	52.55	11.30	3	12.50	10.20	do	67	68	66	4		68	63	65	63	63
17	3500	do	49	79	94.83	81.76	do	100	93.7	52.55	11.30	3	12.50	10.21	do	66	70	59	4		68	63	65	63	63
18	3500	do	50	83	94.70	83.43	do	100	93.7	52.55	11.30	3	12.50	10.21	do	74	83	67	5		71	63	65	63	63
19	3600	do																							

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TABLE No. 8.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—Continued.

[Per cent of increase, 7 to 28 days.]

Reference.	No. of barrel.	Cement.				Sand.						Water as per cent of dry ingredients.	Date made.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.					Moldier.
		Kind.	Time of setting.		Fineness.		Kind.	Fineness.			Parts to one of cement.				Mean.	Highest.	Lowest.	Number averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.	
			To bear ¼-inch wire, weighing ¼ pound.	To bear ¼-inch wire, weighing 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.		Per cent passing No. 10.	Per cent passing No. 30.	Per cent passing No. 50.														
	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
			Min.	Min.																				
1	2700	Natural	56	74	87.43		Lake	100	98.7	82.55	11.30	12.50	1896.	28 days	149	159	118	5	17.32	67	67	67	61	61
2	2760	do	55	80	90.00		do	100	98.7	82.55	11.30	12.50	12.19	do	136	133	121	4	6.38	67	67	67	61	61
3	2820	do	48	77	91.28		do	100	98.7	82.55	11.30	12.50	12.19	do	115	126	108	5	45.56	67	67	67	61	61
4	2880	do	57	77	92.64		do	100	98.7	82.55	11.30	12.50	12.22	do	109	150	100	4	57.97	67	67	67	61	61
5	2940	do	35	66	96.64		do	100	98.7	82.55	11.30	12.50	12.22	do	184	207	169	5	142.86	67	67	67	61	61
6	2960	do	50	74	94.20		do	100	98.7	82.55	11.30	12.50	12.24	do	155	190	121	5	94.56	67	67	67	61	61
7	3000	do	40	74	85.94		do	100	98.7	82.55	11.30	12.50	12.24	do	87	100	76	5	16.13	67	67	67	61	61
8	3060	do	51	83	95.28		do	100	98.7	82.55	11.30	12.50	1897.	do	104	121	91	5	6.13	67	67	67	61	61
9	3120	do	50	82	95.80		do	100	98.7	82.55	11.30	12.50	3.31	do	126	146	108	5	4.38	67	67	67	61	61
10	3180	do	50	78	96.25		do	100	98.7	82.55	11.30	12.50	4.2	do	149	166	134	5	18.74	67	67	67	61	61
11	3240	do	49	80	97.15		do	100	98.7	82.55	11.30	12.50	4.2	do	101	114	94	5	10.80	67	67	67	61	61
12	3300	do	55	80	95.10		do	100	98.7	82.55	11.30	12.50	4.5	do	106	110	100	5	16.48	67	67	67	61	61
13	3360	do	43	72	94.53		do	100	98.7	82.55	11.30	12.50	4.7	do	104	113	98	5	50.73	67	67	67	61	61
14	3420	do	43	79	93.20		do	100	98.7	82.55	11.30	12.50	4.7	do	125	141	117	5	88.89	67	67	67	61	61
15	3480	do	53	79	92.60		do	100	98.7	82.55	11.30	12.50	4.9	do	133	139	120	5	69.44	67	67	67	61	61
16	3540	do	48	75	94.80		do	100	98.7	82.55	11.30	12.50	4.9	do	108	115	103	5	83.73	67	67	67	61	61
17	3600	do	49	79	94.85		do	100	98.7	82.55	11.30	12.50	4.12	do	115	127	93	5	74.34	67	67	67	61	61
18	3660	do	49	82	94.70		do	100	98.7	82.55	11.30	12.50	4.15	do	98	102	89	5	35.33	67	67	67	61	61
19	3660	do	50	82	92.48		do	100	98.7	82.55	11.30	12.50	4.19	do	127	136	114	5	71.03	67	67	67	61	61

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TABLE No. 4.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897—Continued.

[Per cent of increase is 7 days to 6 months.]

Reference.	No. of barrel.	Cement. Kind.	Cement. Time of setting. To bear ¼-inch wire, weighing ¼ pound.	Cement. Time of setting. To bear ¼-inch wire, weighing 1 pound.	Cement. Fineness. Per cent passing No. 50.	Cement. Fineness. Per cent passing No. 100.	Sand. Kind.	Sand. Fineness. Per cent passing No. 10.	Sand. Fineness. Per cent passing No. 20.	Sand. Fineness. Per cent passing No. 30.	Sand. Fineness. Per cent passing No. 50.	Parts to one of cement.	Water as per cent of dry ingredients.	Date made.	Age.	Tensile strength. Mean.	Tensile strength. Highest.	Tensile strength. Lowest.	Tensile strength. Number averaged.	Percentage of increase in tensile strength.	Temperature. Air of mixing room.	Temperature. Water in tank.	Temperature. Dry ingredients.	Temperature. Water for mixing.	Molder.
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
			Min.	*Min.*										1896.											
1	2700	Natural	56	74	96.00	87.42	Lake	100	93.7	52.55	11.30	3	12.50	12, 21	6 months	319	336	296	5	151.13	67	63	63	65	s.
2	2760	do	55	80	94.42	80.00	do	100	93.7	52.55	11.30	3	12.50	12, 21	do	328	341	302	5	136.4	67	63	63	65	s.
3	2800	do	46	77	94.90	81.29	do	100	93.7	52.55	11.30	3	12.50	12, 23	do	274	289	267	5	246.8	70	63	65	67	s.
4	2860	do	37	77	94.80	82.64	do	100	93.7	52.55	11.30	3	12.50	12, 23	do	283	309	256	5	210.1	70	63	65	67	s.
5	2900	do	35	63	96.49	86.64	do	100	93.7	52.55	11.30	3	12.50	12, 26	do	273	289	254	5	268.9	69	63	64	65	s.
														1897.											
6	2960	do	50	74	96.19	84.28	do	100	93.7	52.55	11.30	3	12.50	3, 30	do	284	308	263	5	187.8	67	63	63	66	s.
7	3000	do	40	74	95.94	81.30	do	100	93.7	52.55	11.30	3	12.50	4, 1	do	261	276	246	5	242.0	68	63	63	64	s.
8	3060	do	51	88	95.33	82.36	do	100	93.7	52.55	11.30	3	12.50	4, 1	do	343	366	305	5	250.0	68	63	63	64	s.
9	3100	do	50	82	95.80	80.40	do	100	93.7	52.55	11.30	3	12.50	4, 3	do	266	291	255	5	192.3	70	63	65	65	s.
10	3160	do	50	76	96.22	90.31	do	100	93.7	52.55	11.30	3	12.50	4, 3	do	331	361	300	5	152.7	70	63	65	65	s.
11	3200	do	39	76	96.95	84.90	do	100	93.7	52.55	11.30	3	12.50	4, 6	do	332	343	308	5	174.4	68	63	63	64	s.
12	3260	do	48	86	97.16	84.12	do	100	93.7	52.55	11.30	3	12.50	4, 6	do	288	300	276	5	216.5	68	63	63	64	s.
13	3300	do	55	80	96.30	80.10	do	100	93.7	52.55	11.30	3	12.50	4, 8	do	308	319	300	5	346.4	67	63	63	65	s.
14	3360	do	43	72	94.33	79.87	do	100	93.7	52.55	11.30	3	12.50	4, 8	do	228	312	209	5	351.5	67	63	62	65	s.
15	3400	do	48	73	93.20	79.20	do	100	93.7	52.55	11.30	3	12.50	4, 10	do	275	292	257	5	282.0	67	63	62	65	s.
16	3460	do	52	79	93.80	81.60	do	100	93.7	52.55	11.30	3	12.50	4, 10	do	278	289	267	5	314.9	67	63	62	65	s.
17	3500	do	48	75	94.60	82.82	do	100	93.7	52.55	11.30	3	12.50	4, 13	do	304	332	288	5	360.6	67	63	62	65	s.
18	3560	do	49	79	94.85	81.76	do	100	93.7	52.55	11.30	3	12.50	4, 13	do	346	380	330	5	482.3	67	63	62	65	s.
19	3600	do	50	82	94.70	82.43	do	100	93.7	52.55	11.30	3	12.50	4, 19	do	296	321	284	5	300.0	66	63	61	65	s.

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TABLE No. 5.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CONCRETE TESTS, 1897.—TESTS MADE WITH SAMPLES OF NATURAL CEMENT CONCRETE TAKEN FROM CONCRETE CAR AS MIXED FOR THE SUPERSTRUCTURE.

[Briquets very rough.]

Cement.							Sand.						Stone.			
			Time of setting.		Fineness.			Fineness.								
No. of barrel.	No. of briquet.	Brand.	To bear ¼-inch wire, ¼ pound.	To bear ¼-inch wire, 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.	Kind.	Per cent passing No. 10.	Per cent passing No. 20.	Per cent passing No. 30.	Per cent passing No. 50.	Parts to one of cement.	Kind.	Size as broken with pieces over 1½ inches removed.	Parts by weight to one of sand.	Parts by measure to one of sand.
a	b	c	d	e	f	g	h	i	k	l	m	n	o	p	q	r
			Min.	*Min.*												
3402, 3406	7611–15	☆	42	74	95.52	81.89	Lake ...	100	93.07	47.66	5.29	2.76	Quartzite, crushed one-third to pass a 1½-inch ring—two-thirds to pass a 2-inch ring.	¼ inch to 1½ inch	1.8	2
3402, 3406	7616–20	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3402, 3406	7621–25	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3444, 3345	7626–30	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3444, 3345	7631–35	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3444, 3345	7636–40	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3238, 3239	7651–55	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3238, 3239	7656–60	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3238, 3239	7661–75	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3206, 3247	7666–70	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3206, 3247	7671–75	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
3206, 3247	7676–80	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2657, 3010	7681–85	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2657, 3010	7686–90	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2657, 3010	7691–95	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2430, 2456	7696–7700	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2430, 2456	7701– 5	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
2430, 2456	7706–10	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
1106, 2866	7721–25	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
1106, 2866	7726–30	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2
1106, 2866	7731–35	☆	42	74	95.52	81.89	....do ...	100	93.07	47.66	5.29	2.76	.....do	.....do	1.8	2

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TABLE No. 5.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CONCRETE TESTS, 1897.—TESTS MADE WITH SAMPLES OF NATURAL CEMENT CONCRETE TAKEN FROM CONCRETE CAR AS MIXED FOR THE SUPERSTRUCTURE—Continued.

[Briquets very rough.]

Cement.		Water as per cent of cement and sand.	Water as per cent of sand, stone, and cement.	Number of briquets averaged.	Date made.	Age.	Tensile strength.				Temperature.				Molder.	No. of monolith from which sample was taken.	Average percentage of absorption after 16 days in water.
No. of barrel.	No. of briquet.						Mean.	Highest.	Lowest.	Percentage of increase.	Air of mixing room.	Water in tank.	Water of mixing.	Concrete as taken from car.			
a	b	c	d	e	f	g	x	y	z	x'	b'	c'	d'	e'	f'	g'	h'
											°	°	°	°			
3402, 3406	7611-15	13.31	5.73	5	7, 2, 97	7 days	36.4	47	30		76	62	47	70	S.	103	2.72
3402, 3406	7616-20	13.31	5.73	5	7, 2, 97	28 days	138.8	161	100	281.31	76		47	70	S.	103	2.72
3402, 3406	7621-25	13.31	5.73	5	7, 2, 97	6 months	176.4	217	145	388.88	76		47	70	S.	103	2.72
3444, 3345	7626-30	13.31	5.73	5	7, 6, 97	7 days	55.8	60	50		75		46	69	S.	105	2.72
3444, 3345	7631-35	13.31	5.73	5	7, 6, 97	28 days	108.8	123	89	94.98	75		46	69	S.	105	2.72
3444, 3345	7636-40	13.31	5.73	5	7, 6, 97	6 months	171.8	199	139	207.88	75		46	69	S.	105	2.72
3238, 3239	7651-55	13.31	5.73	5	7, 7, 97	7 days	35.6	43	28		78		46	69	S.	107	2.72
3238, 3239	7656-60	13.31	5.73	5	7, 7, 97	28 days	129	166	110	262.36	78		46	69	S.	107	2.72
3238, 3239	7661-75	13.31	5.73	5	7, 7, 97	6 months	216.6	232	206	508.42	78		46	69	S.	107	2.72
3206, 3247	7666-70	13.31	5.73	5	7, 8, 97	7 days	43.6	51	41		74		45	64	S.	96	2.72
3206, 3247	7671-75	13.31	5.73	5	7, 8, 97	28 days	152.4	166	133	249.54	74		45	64	S.	96	2.72
3206, 3247	7676-80	13.31	5.73	5	7, 8, 97	6 months	207.8	236	175	376.60	74		45	64	S.	96	2.72
2657, 3010	7681-85	13.31	5.73	5	7, 9, 97	7 days	42	47	34		72		44	62	S.	100	2.72
2657, 3010	7686-90	13.31	5.73	5	7, 9, 97	28 days	136.3	160	123	225.71	72		44	62	S.	100	2.72
2657, 3010	7691-95	13.31	5.73	5	7, 9, 97	6 months	197.5	218	181	370.24	72		44	62	S.	100	2.72
2430, 2456	7696-7700	13.31	5.73	5	7, 10, 97	7 days	45.2	49	43		69		43	62	S.	102	2.72
2430, 2456	7701- 5	13.31	5.73	5	7, 10, 97	28 days	165.3	176	149	266.31	69		43	62	S.	102	2.72
2430, 2456	7706-10	13.31	5.73	5	7, 10, 97	6 months	220	236	190	386.72	69		43	62	S.	102	2.72
1106, 2866	7721-25	13.31	5.73	5	7, 12, 97	7 days	54.8	61	46		64		50	54	S.	98	2.72
1106, 2866	7726-30	13.31	5.73	5	7, 12, 97	28 days	151.2	166	130	175.91	64		50	54	S.	98	2.72
1106, 2866	7731-35	13.31	5.73	5	7, 12, 97	6 months	217.6	230	208	297.08	64		50	54	S.	98	2.72
2974, 2968	7736-40	13.31	5.73	5	7, 13, 97	7 days	47.8	59	43		65		52	62	S.	104	2.72
2974, 2968	7741-45	13.31	5.73	5	7, 13, 97	28 days	144.2	169	127	201.97	65		52	62	S.	104	2.72
2974, 2968	7746-50	13.31	5.73	5	7, 13, 97	6 months	186	216	150	329.19	65		52	62	S.	104	2.72

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TABLE No. 6.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—DATA OF CONCRETE USED IN THE FOOTING BLOCKS.

Reference.	Cement.					Sand.						Stone.							Made between inclusive dates.
	Brand.	Time of setting.		Fineness.		Kind.	Fineness.				Parts by weight to one of cement.	Kind.	Size.		Parts by weight to one of sand.	Parts by measure to one of sand.	Parts by weight to one of cement.	Water as per cent of cement and sand.	
		To bear ½-inch wire, 1 pound.	To bear ¼-inch wire, 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.		Per cent passing No. 10.	Per cent passing No. 30.	Per cent passing No. 50.	Per cent passing No. 80.			Screenings passing No. 10 sieve.	Screenings passing screen with ½-inch mesh.					
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
		Min.	*Min.*																
1	×	178	274	99.70	92.06	Lake ...	100	98.70	52.55	11.30	2.25	Mixture of trap and quartzite.	24.18	75.82	2.039	2.216	4.60	11.99	12, 24, 96 to 1, 6, 97.
2	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	12, 24, 96 to 1, 6, 97.
3	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	12, 24, 96 to 1, 6, 97.
4	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 7, 97 to 1, 13, 97.
5	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 7, 97 to 1, 13, 97.
6	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 7, 97 to 1, 13, 97.
7	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 13, 97 to 2, 13, 97.
8	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 13, 97 to 2, 13, 97.
9	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	1, 13, 97 to 2, 13, 97.
10	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	2, 15, 97 to 2, 26, 97.
11	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	2, 15, 97 to 2, 26, 97.
12	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	2, 15, 97 to 2, 26, 97.
13	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	7, 24, 97 to 7, 29, 97.
14	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	7, 24, 97 to 7, 29, 97.
15	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.25	.....do	24.18	75.82	2.039	2.216	4.60	11.99	7, 24, 97 to 7, 29, 97.
16	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.819	.....do	8.437	91.563	2.039	2.216	5.75	11.40	7, 31, 97 to 8, 9, 97.
17	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.819	.....do	8.437	91.563	2.039	2.216	5.75	11.40	7, 31, 97 to 8, 9, 97.
18	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.819	.....do	8.437	91.563	2.039	2.216	5.75	11.40	7, 31, 97 to 8, 9, 97.
19	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	1.80	.....do	8.437	91.563	2.04	2.216	3.68	15.84	8, 9, 97.
20	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	1.80	.....do	8.437	91.563	2.04	2.216	3.68	15.84	8, 9, 97.
21	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	1.80	.....do	8.437	91.563	2.04	2.216	3.68	15.84	8, 9, 97.
22	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	2.25	.....do	8.437	91.563	2.04	2.216	4.60	14.19	8, 9, 97.
23	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	2.25	.....do	8.437	91.563	2.04	2.216	4.60	14.19	8, 9, 97.
24	G.	51	88	95.45	83.46	....do ...	100	98.70	52.55	11.30	2.25	.....do	8.437	91.563	2.04	2.216	4.60	14.19	8, 9, 97.
25	×	178	274	99.70	92.06	....do ...	100	98.70	52.55	11.30	2.819	.....do	8.437	91.563	2.04	2.216	5.75	11.40	8, 9, 97 to 8, 14, 97.

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TABLE No. 6.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—DATA OF CONCRETE USED IN THE FOOTING BLOCKS—Continued.

Reference.	Age of briquet.	Tensile strength.				Temperature.				Average percentage of absorption after 30 days in water.	Cost of materials composing 1 cubic yard of concrete.					Cost of material in 1 cubic yard concrete.	Cost of cement per barrel.	Cost of sand per cubic yard.	Cost of broken stone per cubic yard.	Cost of stone screenings per cubic yard.
		Mean tensile strength per square inch.	Inclusive numbers of blocks from which samples were averaged.	Number of briquets averaged.	Percentage of increase.	Air of mixing room.	Water in tank.	Extreme at mixing platform.	Extreme of outside air.		Cement.	Sand.	Stone broken from 1½ to 3 inches.	Stone screenings.						
	t	*m*	*o*	*n*	*p*	*q*	*s*	*d'*	*d''*	*e'*	*d''*	*e'*	*f'*	*g'*		*h'*	*i'*	*j'*	*k'*	*l'*
						°	°	°	°											
1	7 days	174.1	1 to 10	30	.....	67.6	63	53	47	2.443	$3.91	$0.203	.....	$1.10		$6.213	$2.75	$0.45	$1.65	$1.10
2	28 days	265.1	1 to 10	30	46.88	67.6	63	58	47	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
3	6 months	286	1 to 10	30	121.71	67.6	63	44	11	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
4	7 days	147.6	11 to 20	30	.....	66.8	63	56	34	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
5	28 days	224.5	11 to 20	30	52.27	66.8	67	43	—4	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
6	6 months	251.9	11 to 20	30	132.41	66.8	67	56	—4	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
7	7 days	137.1	21 to 30	30	.....	66.1	67	56	—15	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
8	28 days	219.8	21 to 30	30	60.32	66.1	67	40	—15	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
9	6 months	245.6	21 to 30	30	153.07	66.1	67	56	—15	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
10	7 days	149.1	31 to 40	30	.....	73.6	67	57	—8	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
11	28 days	213.6	31 to 40	30	43.27	73.6	67	42	—8	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
12	6 months	265.5	31 to 40	30	145.20	73.6	67	57	—8	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
13	7 days	154.4	41 to 52	30	.....	70.5	67	55	77	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10
14	28 days	228	41 to 52	30	41.73	70.5	67	55	77	2.443	3.91	.203	.....	1.10		6.213	2.75	.45	1.65	1.10

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TABLE No. 7.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—DATA OF CONCRETE USED IN THE FOOTING BLOCKS—Continued.

Reference.	Cement.				Sand.						Stone.						Made between inclusive dates.
		Time of setting.		Fineness.		Fineness.			Kind.		Kind.	Size.		Parts by weight to one of cement.	Parts by measure to one of sand.	Parts by weight to one of cement.	Water as per cent of cement and sand.	
	Brand.	To bear ¼-inch wire, ¼ pound.	To bear ¼-inch wire, 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.	Per cent passing No. 10.	Per cent passing No. 30.	Per cent passing No. 50.	Per cent passing No. 80.			Screenings passing No. 10 sieve.	Screenings passing 1-inch mesh.				
	a	b	c	d	e	f	g	h	i	j	k	m	n	o	p	q	r	s
34		Min. 178	Min. 274	99.70	99.06	...	100	98.70	52.55	11.30	Lake	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 9, 1, 97.
35	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 9, 1, 97.
36	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 9, 1, 97.
37	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 1, 97 to 9, 8, 97.
38	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 1, 97 to 9, 8, 97.
39	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 1, 97 to 9, 8, 97.
40	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 8, 97 to 9, 14, 97.
41	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 8, 97 to 9, 14, 97.
42	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 8, 97 to 9, 14, 97.
43	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 8, 97 to 9, 14, 97.
44	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 14, 97 to 9, 20, 97.
45	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 14, 97 to 9, 20, 97.
46	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 14, 97 to 9, 20, 97.
47	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 20, 97 to 9, 26, 97.
48	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 20, 97 to 9, 26, 97.
49	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 20, 97 to 9, 26, 97.
50	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 10, 1, 97.
51	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 10, 1, 97.
52	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	6, 26, 97 to 10, 1, 97.
53	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	10, 1, 97 to 10, 7, 97.
54	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	10, 1, 97 to 10, 7, 97.
55	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	10, 7, 97 to 10, 13, 97.
56	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	10, 7, 97 to 10, 13, 97.
57	×	178	274	99.70	99.06	do	100	98.70	52.55	11.30	do	2.457	91.563	2.04	2.216	5.75	11.40	10, 13, 97 to 10, 19, 97.

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59		178	274	99.70	92.06	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,13,97 to 10,19,97.
60		178	274	99.70	92.06	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,13,97 to 10,19,97.
61		178	274	99.70	92.06	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,19,97; 10,22; 10, 28.
62	×	178	274	99.70	92.06	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,19,97; 10,22; 10, 28.
63	×	178	274	99.70	92.06	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,19,97; 10,22; 10, 28.
64	H	84	210	100	92.86	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,22,97 to 10,28,97.
65	H	84	210	100	92.86	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,22,97 to 10,28,97.
66	H	84	210	100	92.86	....do	100	93.70	52.55	11.30	2.819	....do		8.437	91.563	2.04	2.216	5.75	11.40	10,22,97 to 10,28,97.

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TABLE NO. 7.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—DATA OF CONCRETE USED IN THE FOOTING BLOCKS—Continued.

Reference.	Age of briquet.	Tensile strength.				Temperature.				Average percentage of absorption after 28 days in water.	Cost of materials composing 1 cubic yard of concrete.				Cost of materials in 1 cubic yard concrete.	Cost of cement per barrel.	Cost of sand per cubic yard.	Cost of broken stone per cubic yard.	Cost of stone screenings per cubic yard.
		Mean tensile strength per square inch.	Inclusive numbers of blocks from which samples were averaged.	Number of briquets averaged.	Percentage of increase.	Air of mixing room.	Water in tank.	Extremes at mixing platform.	Extremes of outside air.		Cement.	Sand.	Stone broken from 1½ to 2 inches.	Stone screenings.					
	t	*u*	*v*	*w*	*x*	*y*	*z*	*a'*	*b'*	*c'*	*d'*	*e'*	*f'*	*g'*	*h'*	*i'*	*j'*	*k'*	*l'*
						°	°	°	°										
34	7 days	107.4	98 to 107	30	.....	64.9	65	33 to 45	33 to 45	$3.330	$3.126	$0.153	$0.55	$0.366	$4.195	$2.75	$0.34	$1.65	$1.10
35	28 days	165.2	98 to 107	30	53.81	64.9	65	33 to 45	33 to 45	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
36	6 months	253.3	98 to 107	29	136.21	64.9	65	33 to 45	33 to 45	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
37	7 days	113.7	108 to 117	30	.....	69.1	66	34 to 54	34 to 54	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
38	28 days	162	108 to 117	30	42.48	69.1	66	34 to 54	34 to 54	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
39	6 months	256.3	108 to 117	30	127.17	69.1	67	34 to 54	34 to 54	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
40	7 days	123.2	118 to 127	30	.....	73.7	68	36 to 52	36 to 52	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
41	28 days	168.6	118 to 127	29	32.79	73.7	68	36 to 52	36 to 52	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
42	6 months	240.1	118 to 127	30	94.88	73.7	68	36 to 52	36 to 52	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
43	7 days	114	128 to 137	30	.....	68.4	67	39 to 70	39 to 70	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
44	28 days	164.1	128 to 137	30	43.94	68.4	67	39 to 70	39 to 70	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
45	6 months	264.7	128 to 137	30	132.19	68.4	67	39 to 70	39 to 70	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
46	7 days	123.1	138 to 147	30	.....	70.3	68	40 to 78	40 to 78	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
47	28 days	177	138 to 147	30	43.78	70.3	68	40 to 78	40 to 78	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10

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48	6 months	262.7	138 to 147	30	113.40	70.3	68	78 40	78 40	78 40	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
49	7 days	118.4	148 to 157	30	.....	69.1	68	90	90	90	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
50	28 days	164.4	148 to 157	30	88.85	69.1	68	44	44	44	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
51	6 months	271.6	148 to 157	26	120.89	69.1	68	90	90	90	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
52	7 days	111.5	158 to 167	30	.....	65.7	66	82	82	82	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
53	28 days	160.4	158 to 167	30	43.85	65.7	65	82	82	82	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
54	6 months	262.3	158 to 167	28	135.24	65.7	66	83	83	83	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
55	7 days	121.8	168 to 177	30	.....	68.2	65	90	90	90	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
56	28 days	168.3	168 to 177	30	84.07	68.2	65	35 80	35 80	35 80	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
57	6 months	241.9	168 to 177	29	98.60	68.2	65	35 80	35 80	35 80	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
58	7 days	109.9	178 to 187	30	.....	68.5	65	35 59	35 59	35 59	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
59	28 days	146.8	178 to 187	30	33.14	68.5	65	35 59	35 59	35 59	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
60	6 months	243.3	178 to 187	30	121.38	68.5	65	35 59	35 59	35 59	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
61	7 days	110.3	188 to 194,204	24	.....	68.1	65	33 71	33 71	33 71	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
62	28 days	155.6	188 to 194,204	24	41.07	68.1	65	33 71	33 71	33 71	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
63	6 months	251.7	188 to 194,204	23	128.19	68.1	65	33 71	33 71	33 71	3.330	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
64	7 days	135.8	198 to 203	27	.....	68.7	65	33 71	33 71	33 71	2.968	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
65	28 days	197.3	198 to 203	26	47.80	68.7	65	33 71	33 71	33 71	2.968	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10
66	6 months	290.3	198 to 203	27	114.93	68.7	65	33 71	33 71	33 71	2.968	3.126	.153	.55	.366	4.195	2.75	.34	1.65	1.10

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TABLE No. 8.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—COMPARISON OF PORTLAND CEMENT MORTARS OF EQUAL COST AS THE MORTAR OF NATURAL CEMENT USED IN THE CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER AT MARQUETTE, MICH.

Reference.	Cement. Briquet No.	Brand.	Time of setting. To bear ¼-inch wire weighing ¼ pound.	Time of setting. To bear ¼-inch wire weighing 1 pound.	Fineness. Per cent passing No. 50.	Fineness. Per cent passing No. 100.	Sand. Kind.	Fineness. Per cent passing No. 10.	Fineness. Per cent passing No. 20.	Fineness. Per cent passing No. 30.	Fineness. Per cent passing No. 50.	Parts to one of cement.	Water as per cent of dry ingredients.	Date made.	Age.
a	a	b	c	d	e	f	g	h	j	k	l	m	n	o	p
			Min.	Min.											
1	9451-60 9481-90	G[a]	47	84	96.49	84.05	Lake	100	93.07	47.66	5.29	2.76	13.31	10, 13, 97	7 days.
2	9461-70 9491-9500	H	102	302	99.42	93.42	....do	100	93.07	47.66	5.29	4.86	11.70	10, 13, 97	Do.
3	9471-80 9501-10	Q	84	299	99.13	94.13	....do	100	93.07	47.66	5.29	4.86	11.70	10, 13, 97	Do.
4	6991-7010	×	229	322	99.73	94.54	....do	100	93.07	47.66	5.29	4.86	11.70	5, 14, 97	Do.
5	9871-90	S	112	257	99.06	93.44	....do	100	93.07	47.66	5.29	4.30	10.45	11, 3, 97	Do.
6	9511-20 9541-50	G[a]	47	84	96.49	84.05	....do	100	93.07	47.66	5.29	2.76	13.31	10, 15, 97	28 days.
7	9523-30 9561-60	H	102	302	99.42	93.42	....do	100	93.07	47.66	5.29	4.86	11.70	10, 15, 97	Do.
8	9533-40 9561-70	Q	84	299	99.13	94.13	....do	100	93.07	47.66	5.29	4.86	11.70	10, 15, 97	Do.
9	6941-60	×	229	322	99.73	94.54	....do	100	93.07	47.66	5.29	4.86	11.70	5, 13, 97	Do.
10	9831-50	S	112	257	99.06	93.44	....do	100	93.07	47.66	5.29	4.30	10.45	11, 2, 97	Do.
11	9571-80 9601-10	G[a]	47	84	96.49	84.05	....do	100	93.07	47.66	5.29	2.76	13.31	10, 18, 97	6 months.
12	9581-90 9611-20	H	102	302	99.42	93.42	....do	100	93.07	47.66	5.29	4.86	11.70	10, 18, 97	Do.
13	9591-9600 9621-30	Q	84	299	99.13	94.13	....do	100	93.07	47.66	5.29	4.86	11.70	10, 18, 97	Do.
14	7041-60	×	229	322	99.73	94.54	....do	100	93.07	47.66	5.29	4.86	11.70	5, 15, 97	Do.
15	9911-30	S	112	257	99.06	93.44	....do	100	93.07	47.66	5.29	4.30	10.45	11, 4, 97	Do.
16	6791-6810	G[a]	47	84	96.49	84.05	....do	100	93.07	47.66	5.29	2.76	13.31	5, 10, 97	1 year.
17	7091-7110	×	229	322	99.73	94.54	....do	100	93.07	47.66	5.29	4.86	11.70	5, 19, 97	Do.

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TABLE No. 8.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—COMPARISON OF PORTLAND CEMENT MORTARS OF EQUAL COST, ETC.—Continued.

Reference.	Briquet No. (cement).	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Cost per barrel.	Number of barrel sampled.	Remarks.
		Mean.	Highest.	Lowest.	Number averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.				
	s	q	r	s	t	u	v	w	x	y	z			
1	9451-60 9481-90	67	81	54	20	.....	° 67	° 65	° 62	° 63	S.	$1.15	3110	Consistency of mortar O. K.
2	9461-70 9491-9500	125	143	114	20	.....	67	65	62	63	S.	2.75	3670	Do.
3	9471-80 9501-10	83	98	72	20	.....	67	65	62	63	S.	2.75	Sample 2	Do.
4	6991-7010	128	144	110	20	.....	66	65	62	63	S.	2.75	1940	Do.
5	9871-90	92	98	81	20	.....	67	65	62	63	S.	2.20	Taken from 10 barrels	Trifle dry.
6	9511-20 9541-50	172	191	154	20	156.71	66	65	62	63	S.	1.15	3110	Consistency of mortar O. K.
7	9523-30 9561-60	198	217	179	18	58.40	66	65	62	63	S.	2.75	3670	Do.
8	9533-40 9561-70	164	171	130	18	97.59	66	65	62	63	S.	2.75	Sample 2	Do.
9	6941-60	175	194	156	20	36.71	66	65	62	63	S.	2.75	1940	Do.
10	9831-50	198	226	174	20	115.21	68	65	62	63	S.	2.20	Taken from 10 barrels	Trifle dry.
11	9571-80 9601-10	.....	.....	.....	.....	.....	68	65	62	63	S.	1.15	3110	Consistency of mortar O. K.
12	9581-90 9611-20	.....	.....	.....	.....	.....	68	65	62	63	S.	2.75	3670	Do.
13	9591-9600 9621-30	.....	.....	.....	.....	.....	68	65	62	63	S.	2.75	Sample 2	Do.
14	7041-60	286	306	272	20	123.43	68	65	62	63	S.	2.75	1940	Do.
15	9911-30	.....	.....	.....	.....	.....	68	65	62	63	S.	2.20	Taken from 10 barrels	Trifle dry.
16	6791-6810	.....	.....	.....	.....	.....	67	65	62	63	S.	1.15	3110	Consistency of mortar O. K.
17	7091-7110	.....	.....	.....	.....	.....	65	65	62	63	S.	2.75	1940	Do.

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TABLE NO. 9.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—TO SHOW EFFECT OF SMALL VARIATION IN PERCENTAGE OF WATER WITH SAME BRAND OF PORTLAND CEMENT.

Reference.	Cement.						Sand.						Water as per cent of dry ingredients.	Date made.	Age.
			Time of setting.		Fineness.			Fineness.							
	Briquet No.	Brand.	To bear ¼-inch wire weighing ¼ pound.	To bear ¼-inch wire weighing 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.	Kind.	Per cent passing No. 10.	Per cent passing No. 20.	Per cent passing No. 40.	Per cent passing No. 50.	Parts to one of cement.			
	a	b	c	d	e	f	g	h	j	k	l	m	n	o	p
			Min.	*Min.*											
1	7211-30	S.	112	257	99.08	93.44	Lake	100	93.07	47.66	5.29	0	18.66	5, 26, 97	7 days.
2	7236-55	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	0	20.83	5, 26, 97	Do.
3	7261-80	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	1	12.31	5, 27, 97	Do.
4	7286-7305	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	1	15.00	5, 27, 97	Do.
5	7311-30	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	2	12.00	5, 28, 97	Do.
6	7336-55	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	2	12.37	5, 28, 97	Do.
7	7361-80	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	3	11.00	5, 29, 97	Do.
8	7386-7405	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	3	12.50	5, 29, 97	Do.
9	7411-30	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	0	18.66	5, 31, 97	28 days.
10	7436-55	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	0	20.83	5, 31, 97	Do.
11	7461-80	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	1	12.31	6, 2, 97	Do.
12	7485-7505	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	1	15.00	6, 2, 97	Do.
13	7511-30	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	2	12.00	6, 7, 97	Do.
14	7536-55	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	2	12.37	6, 7, 97	Do.
15	7561-80	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	3	11.00	6, 9, 97	Do.
16	7586-7605	S.	112	257	99.08	93.44	....do	100	93.07	47.66	5.29	3	12.50	6, 9, 97	Do.

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TABLE No. 9.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897.—TO SHOW EFFECT OF SMALL VARIATION IN PERCENTAGE OF WATER, ETC.—Continued.

Reference.	Briquet No. (cement).	Tensile strength.				Percentage of increase in tensile strength in 28 days.	Temperature.				Molder.	Remarks.
		Mean.	Highest.	Lowest.	Number averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
	a	q	r	s	t	u	v	w	x	y	z	
							°	°	°	°		
1	7211-80	715	836	600	20	.....	67	60	65	63	S.	Mortar hard to gauge.
2	7236-55	602	691	500	20	.....	67	60	65	63	S.	Mortar trifle moist.
3	7261-80	492	520	460	20	.....	68	60	65	62	S.	Mortar consistency O. K.
4	7286-7305	384	406	362	20	.....	68	60	65	62	S.	Mortar trifle moist.
5	7311-80	330	355	300	20	.....	67	60	65	63	S.	Mortar consistency O. K.
6	7336-55	288	316	250	20	.....	67	60	65	62	S.	Mortar trifle moist.
7	7361-80	229	258	200	20	.....	68	60	65	62	S.	Mortar consistency O. K.
8	7386-7405	182	206	161	20	.....	68	60	65	62	S.	Mortar trifle moist.
9	7411-30	728	830	642	20	1.81	68	60	66	62	S.	Mortar hard to gauge.
10	7436-55	661	758	586	20	13.12	68	60	65	62	S.	Mortar trifle moist.
11	7461-80	639	709	591	20	29.37	67	60	65	63	S.	Mortar consistency O. K.
12	7485-7505	624	696	567	20	62.50	67	60	65	62	S.	Mortar trifle moist.
13	7511-30	525	554	490	20	50.09	68	60	65	62	S.	Mortar consistency O. K.
14	7536-55	470	502	432	20	63.19	68	60	65	62	S.	Mortar trifle moist.
15	7561-80	385	403	359	20	68.12	68	60	65	62	S.	Mortar consistency O. K.
16	7586-7605	312	334	296	20	71.48	68	60	65	62	S.	Mortar trifle moist.

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TABLE No. 10.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1898.

Reference.		Cement.					Sand.							Date made.	Age.
	No. of barrel.	Kind.	Time of setting.		Fineness.		Kind.	Fineness.				Parts to 1 of cement.	Water as per cent of dry ingredients.		
			To bear ¼ inch wire weighing ¼ pound.	To bear ¼ inch wire weighing 1 pound.	Per cent passing No. 50.	Per cent passing No. 100.		Per cent passing No. 10.	Per cent passing No. 20.	Per cent passing No. 50.	Per cent passing No. 100.				
	a	b	c	d	e	f	g	h	i	k	l	m	n	o	p
1	3660	Empire Portland	*Min.* 77	*Min.* 172	100	92.80	Lake	100	93.07	47.66	5.29	3	10	9.10.97	7 days.
2	3660	do	77	172	100	92.80	do	100	93.07	47.66	5.29	3	10	9.14.97	28 days.
3	3660	do	77	172	100	92.80	do	100	93.07	47.66	5.29	3	10	10.20.97	6 months.
4	3665	do					do	100	93.07	47.66	5.29	3	10	9.10.97	7 days.
5	3665	do					do	100	93.07	47.66	5.29	3	10	9.14.97	28 days.
6	3665	do					do	100	93.07	47.66	5.29	3	10	10.20.97	6 months.
7	3670	do	75	181	100	93.12	do	100	93.07	47.66	5.29	3	10	9.13.97	7 days.
8	3670	do	75	181	100	93.12	do	100	93.07	47.66	5.29	3	10	9.14.97	28 days.
9	3670	do	75	181	100	93.12	do	100	93.07	47.66	5.29	3	10	10.20.97	6 months.
10	3675	do					do	100	93.07	47.66	5.29	3	10	9.13.97	7 days.
11	3675	do					do	100	93.07	47.66	5.29	3	10	9.14.97	28 days.
12	3675	do					do	100	93.07	47.66	5.29	3	10	10.20.97	6 months.
13	3680	do	83	187	100	92.65	do	100	93.07	47.66	5.29	3	10	9.13.97	7 days.
14	3680	do	83	187	100	92.65	do	100	93.07	47.66	5.29	3	10	9.14.97	28 days.
15	3680	do	83	187	100	92.65	do	100	93.07	47.66	5.29	3	10	10.20.97	6 months.

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TABLE NO. 10.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1898—Continued.

Reference.	No. of barrel.	Kind of cement.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Remarks.
			Mean.	Highest.	Lowest.	Number averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
	a	b	q	r	s	t	u	v	w	x	y	z	
								°	°	°	°		
1	3660	Empire Portland	306	322	289	5	.....	68	62	65	63	S.	Consistency of mortar O. K.
2	3660	.....do	368	387	333	5	20.26	78	62	65	63	S.	Do.
3	3660	.....do	437	459	422	5	42.81	70	62	65	63	S.	Do.
4	3665	.....do	330	349	290	5	.....	68	62	65	63	S.	Do.
5	3665	.....do	362	391	303	5	9.69	73	62	65	63	S.	Do.
6	3665	.....do	468	477	450	5	41.81	70	62	65	63	S.	Do.
7	3670	.....do	295	302	290	5	.....	60	62	65	63	S.	Do.
8	3670	.....do	391	399	385	5	32.54	73	62	65	63	S.	Do.
9	3670	.....do	433	464	406	5	46.78	70	62	65	63	S.	Do.
10	3675	.....do	291	310	275	5	.....	69	62	65	63	S.	Do.
11	3675	.....do	389	418	357	5	33.67	73	62	65	63	S.	Do.
12	3675	.....do	422	434	405	5	45.01	69	62	65	63	S.	Do.
13	3680	.....do	307	330	287	5	.....	69	62	65	63	S.	Do.
14	3680	.....do	391	406	378	5	27.36	73	62	65	63	S.	Do.
15	3680	.....do	423	449	402	5	37.45	69	62	65	63	S.	Do.

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TABLE No. 11.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1892—Continued.

Reference.	Briquet No.	Cement.					Pebbles or broken stone.					Sand.				
		Kind.	Grams.	Time setting.		Fineness.	Kind.	Grams.	Fineness.	Voids (per cent).	Volume.	Kind.	Grams.	Fineness.	Voids (per cent).	Volume.
				To bear ¼ inch wire weighing ¼ pound.	To bear ¼ inch wire weighing 1 pound.	Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.									
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
				Min.	Min.												
1	10501–10	H	200	135	345	98.42	98.42	Lake	348	2–10	43	.....	Lake	263	10–30, 20–30, 30–50.	40	100
2	10501–60	H	200	135	345	98.42	98.42	Quartzite	300	2–10	50	.....	Quartzite	300		33	125
3	10501–10	H	200	135	345	98.42	98.42	Trap	282	2–10	53	.....	Trap	318		33	125
4	10511–20	H	200	135	345	98.42	98.42	Lake	348	2–10	43	.....	Lake	252		40	100
5	10561–70	H	200	135	345	98.42	98.42	Quartzite	300	2–10	50	.....	Quartzite	300		33	125
6	10611–20	H	200	135	345	98.42	98.42	Trap	282	2–10	53	.....	Trap	318		33	125
7	10541–50	H	200	135	345	98.42	98.42	Lake	348	2–10	43	.....	Lake	263		40	100
8	10591–600	H	200	135	345	98.42	98.42	Quartzite	300	2–10	50	.....	Quartzite	300		33	125
9	10041–50	H	200	135	345	98.42	98.42	Trap	282	2–10	53	.....	Trap	318		33	125
10	10951–60	H	200	135	345	98.42	98.42	Lake	a 348	2–10	43	.....	Lake	252		40	100
11	10961–70	H	200	135	345	98.42	98.42	....do	a 348	2–10	43	.....	....do	252		40	100
12	10981–11000	H	200	135	345	98.42	98.42	....do	a 348	2–10	43	.....	....do	252		40	100

a 6.26 per cent of the weaker slaty or sandstone pebbles was removed.

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TABLE No. 11.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1898—Continued.

Reference.	Briquet No.	Water as per cent dry ingredients.	Date made.	Age.	Tensile strength.				Temperature (° F.).				Molder.
					Mean.	Highest.	Lowest.	Number averaged.	Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.	
	q	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	*aa*	*bb*	*cc*
			1898.										
1	10501-10	8	1,3	7 days	389	431	364	10	71	66	65	66	S. S. S. S. S. S.
2	10551-60	10	1,4	....do	371	399	341	10	70	65	65	65	
3	10601-10	15	1,5	....do	363	392	344	10	72	67	65	67	
4	10511-20	8	1,3	28 days	481	498	443	10	71	66	65	66	
5	10561-70	10	1,4	....do	431	462	400	10	70	65	65	65	
6	10611-20	15	1,5	....do	465	492	440	10	72	67	65	67	
7	10541-50	8	1,3	3 months	552	610	503	10	71	66	65	66	
8	10591-600	10	1,4	....do	550	610	500	10	70	65	65	65	
9	10641-50	15	1,5	....do	520	598	464	10	72	67	65	67	
10	10951-60	8	1,13	7 days	399	424	377	9	73	68	65	68	
11	10961-70	8	1,13	28 days	534	554	510	10	73	68	65	68	
12	10991-11000	8	1,13	3 months	580	614	539	10	73	68	65	68	

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TABLE No. 12.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897—Continued.

Reference.	Briquet No.	Cement. Kind.	Cement. Time setting. To bear ¼-inch wire weighing ¼ pound.	Cement. Time setting. To bear ¼-inch wire weighing 1 pound.	Cement. Fineness. Per cent passing No. 50 sieve.	Cement. Fineness. Per cent passing No. 100 sieve.	Sand. Kind.	Sand. Fineness. Per cent passing No. 10 sieve.	Sand. Fineness. Per cent passing No. 20 sieve.	Sand. Fineness. Per cent passing No. 30 sieve.	Voids (per cent).	Volume.	Parts to one of cement.	Water as per cent of dry ingredients	Date made.
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
			Min.	*Min.*											1897.
1	10051-60	H	135	345	99.42	93.42	Lake	100	93.07	47.66	40	100	3	10.0	12, 21
2	10101-10	H	135	345	99.42	93.42	Quartzite	100	93.07	47.66	50	130	3	13.0	12, 22
3	10151-60	H	135	345	99.42	93.42	Trap	100	93.07	47.66	53	125	3	12.5	12, 23
4	10061-70	H	135	345	99.42	93.42	Lake	100	93.07	47.66	40	100	3	10.0	12, 21
5	10111-20	H	135	345	99.42	93.42	Quartzite	100	93.07	47.66	50	130	3	13.0	12, 22
6	10161-70	H	135	345	99.42	93.42	Trap	100	93.07	47.66	53	125	3	12.5	12, 23
7	10091-100	H	135	345	99.42	93.42	Lake	100	93.07	47.66	40	100	3	10.0	12, 21
8	10141-50	H	135	345	99.42	93.42	Quartzite	100	93.07	47.66	50	130	3	13.0	12, 22
9	10191-200	H	135	345	99.42	93.42	Trap	100	93.07	47.66	53	125	3	12.5	12, 23

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TABLE NO. 12.—*Concrete superstructure to breakwater at Marquette, Mich.*—Continued.

CEMENT TESTING, 1897—Continued.

Reference.	Briquet No.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature (° F.).				Molder.	Remarks.
			Mean.	Highest.	Lowest.	Number averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
	a	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	
1	10051–60	7 days	265	280	259	10	.....	71	66	65	66	S.	
2	10101–10	.....do	267	283	245	10	.....	70	65	65	65	S.	
3	10151–60	.....do	258	276	241	10	.....	72	67	65	67	S.	
4	10061–70	28 days	356	368	344	10	34.34	71	66	65	66	S.	Per cent increase, 7 to 28 days.
5	10111–20	.....do	340	360	305	10	27.30	70	65	65	65	S.	Do.
6	10161–70	.....do	364	384	345	10	41.08	72	67	65	67	S.	Do.
7	10091–100	3 months	469	496	448	10	76.97	71	66	65	66	S.	Per cent increase, 7 days to 3 months.
8	10141–50	.....do	463	480	443	10	73.40	72	67	65	67	S.	Do.
9	10191–200	.....do	464	480	440	10	79.84	70	65	65	65	S.	Do.

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H H 8.

HARBOR OF REFUGE, MARQUETTE BAY, MICHIGAN.

This work was ordered by the act of June 3, 1896.

For the description of the locality and the interests to be benefited by the improvement, see Annual Report, 1896, pages 2385, 2386.

The approved project is the construction of a breakwater 1,000 feet in length on the reef running out from Presque Isle Point in a general southeast direction. This will protect the ore and commercial docks of the Lake Superior and Ishpeming Railway Company and the docks of the Dead River Lumber Company.

The contract with A. & D. Sang for building 500 feet of breakwater was completed by the close of navigation in 1897. In addition, as extra work, a decked crib 50 by 24 by 5 feet 6 inches was built and sunk at the inner end of the breakwater and extending toward shore to break the effect of the waves rolling through the gap between the shore and inner end of the work.

The main work has a slope to the waves from +0.5 feet (L. W. D.) on the outside to +10 feet on the inner side. The experience of the last winter's storms confirms my opinion as to this general form being the one best adapted to permit the waves to slide over and fall harmlessly in the inside with a minimum impact and resistance.

The work was executed under the local direction of Mr. Clarence Coleman, assistant engineer, and Mr. W. H. Hoyt, inspector.

Money statement.

July 1, 1897, balance unexpended	$19,144.05
June 30, 1898, amount expended during fiscal year	18,123.37
July 1, 1898, balance unexpended	1,020.68
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

COMMERCIAL STATISTICS, HARBOR OF REFUGE, MARQUETTE BAY, MICH.

Receipts and shipments, 1897.

Shipments.	Tons.	Receipts.	Tons.
Iron ore	1,035,783	Coal	27,913
Lumber	31,547		
Total	1,067,330		

Receipts and shipments for two years.

	1896.	1897.
	Tons.	Tons.
Receipts	8,523	27,913
Shipments	839,258	1,067,330
Total	847,781	1,095,243
Increase		747,462

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Arrivals and departures of vessels for two years.

	Arrivals.	Departures.	Total.
1897	555	555	1,110
1896	207	207	414
Increase	348	348	696

H H 9.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

The harbor of Grand Marais, Mich., was only accessible for vessels drawing less than 9 feet. Once within the bay there is ample depth to float the largest vessels. As a harbor of refuge it is of pressing importance to the shipping navigating the lakes in this vicinity.

The project for the improvement of this harbor was adopted in 1881, and has for its object the creation of a safe entrance into the bay for vessels of the largest size. The entrance is 500 feet wide, protected by crib piers on either side. The west pier is now 1,656 feet long, including 100 feet of pile dike, and the east pier 1,153 feet long, including 100 feet of pile dike.

A careful and comprehensive survey made in the fall of 1894 showed, when compared with previous surveys, that the harbor was slowly but surely filling up by the sand rolled in by the waves through the interval of 5,700 feet between the east pier and the eastern shore.

This fact necessitated an amendment of the project by providing for a close pile dike across this open interval. This was approved by the Chief of Engineers, December 21, 1894.

A channel 150 feet wide and 17 feet deep was dredged out between the piers in 1889.

An examination made in June, 1890, showed considerable shoaling, and in 1891 it was again dredged, this time to a width of 175 feet and a least depth of over 17 feet. A partial survey made in June, 1893, showed a shoaling to 14 feet, principally opposite the portion of the west pier which extends beyond the east pier, so that with any swell on it would not be safe to bring in a vessel of more than 12 feet draft.

An examination made in June, 1894, showed that there was a least depth of 15.5 feet along the channel, and this, as before, opposite the west pier where it extends beyond the east pier.

The amount expended on the above project as amended in 1894, up to the close of the fiscal year ending June 30, 1897, was $285,750.83.

At that time there was a navigable channel of 15 feet into and between the piers. This channel has shoaled somewhat since, and a bar has worked in from the west, its edge with but 12 feet on being opposite the prolongation of the axis of the channel between the piers. The sand about Grand Marais is very shifting and treacherous, with greatly varying degrees of firmness and stability. At present the harbor entrance is available for vessels drawing only 13 feet. To secure 16-foot navigation through the entrance, which will be ample for the commerce of the port and for refuge for all but the largest class of vessels, the piers should be fully and rapidly extended to the 20-foot curve, and a wide and deep channel dredged out between the piers; and to preserve this it may be necessary to reduce the canalized entrance to a width of 300 feet. The gap of 318 feet in the pile dike across the

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natural entrance, unclosed at the date of the last Annual Report, was completed with hired labor and plant owned by the United States, by the close of navigation in 1897, at a total cost somewhat less than the original estimate. A few breaks have occurred since its completion, but they were promptly repaired at small cost, and the dike is now in good condition after the fall and winter storms and the crushing, drifting, and grinding action of the ice last winter. It is being gradually strengthened by sand accumulating against it. The protection afforded by it to the bay behind it has been extensively utilized for the booming and storage of acres of logs, leaving, however, plenty of room for anchorage.

The contract in force at the date of the last Annual Report, for constructing 250 feet of extension to the west pier, was practically completed June 30, 1898.

The renewed growth and prosperity of the town of Grand Marais, reported in my last two annual reports, have been maintained during the past year, and another shingle mill has been built.

The work has been continued under Mr. E. S. Long, assistant engineer and inspector.

The commerce of this place has increased from 1,910 tons in 1887 to 142,536 tons in 1897. While the expenditure for this harbor is incidentally an aid to the local commerce, the great object is the affording a harbor of refuge for the general lake commerce. In 1892 310 vessels entered and departed; in 1897 807 vessels entered and departed.

Original estimate (see Report of Chief of Engineers, 1881, p. 2053)	$450,000
Modified by authority of Chief of Engineers, December 21, 1894, to include pile dike	34,000
Total	484,000
Appropriated	305,250

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich.; nearest light-house, Grand Marais, Mich.

Money statement.

July 1, 1897, balance unexpended		$19,499.17
June 30, 1898, amount expended during fiscal year		13,446.56
July 1, 1898, balance unexpended		6,052.61
July 1, 1898, outstanding liabilities	$898.80	
July 1, 1898, amount covered by uncompleted contracts	4,998.00	
		5,896.80
July 1, 1898, balance available		155.81

Amount (estimated) required for completion of existing project	178,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Abstract of appropriations for improving harbor of refuge at Grand Marais, Mich.

By act of Congress—		By act of Congress—	
Approved June 14, 1880	$10,000	Approved September 19, 1890	$50,000
Approved March 3, 1881	20,000	Approved July 13, 1892	30,000
Passed August 2, 1882	40,000	Of August 18, 1894	20,000
Approved July 5, 1884	35,000	Passed June 3, 1896	24,000
Approved August 5, 1886	26,250		
Of August 11, 1888	50,000	Total	305,250

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COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Mich.

Year.	Vessels.	Arrivals.	Clearances.
1892	Steam	155	155
1893	Steam, 187 (tonnage, 26,645); sail, 11 (tonnage, 10,000)	198	197
1894	Steam, 160; barges, 30 (tonnage, 69,300); sail, 3	193	192
1895	Steam, 219 (tonnage, 78,000); sail and tow, 44 (tonnage, 26,800)	263	261
1896	Steam, 224 (tonnage, 210,000); sail and tow, 104 (tonnage, 100,000)	328	323
1897	Steam, 287 (tonnage, 300,000); sail and tow, 117 (tonnage, 200,000)	404	403

Principal articles of export and import.

Exports.	Tons.	Imports.	Tons.
Lumber and logs	124,000	Merchandise	4,500
Shingles	1,148	Coal	6,000
Lath	2,788	Hay	1,500
Fish	600	Oats	2,000
Total	128,536	Total	14,000
Valuation	$600,000	Valuation	$780,675

Receipts and shipments for eleven years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,910	1891	1,356	1895	56,208
1888	6,270	1892	5,020	1896	90,497
1889	8,686	1893	35,450	1897	142,586
1890	9,405	1894	39,250		

Approximate value of commerce:

1896	$691,650
1897	1,380,675

H H 10.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On July 19, 1881, the steamer *Winnipeg* caught fire while lying at the dock in Duluth and was towed out into the bay, where it sunk in about 8 feet of water and the top burned down to the water's edge.

The wreck has for years been a menace to small-boat navigation in the harbor and permission to remove it was granted January 24, 1898, under the act of June 14, 1880. After due advertisement a contract was made with B. B. Inman, of Duluth, to remove it for $1,300. It has been broken up with dynamite placed by a diver and the wreckage will all be removed by August 1, 1898.

NOTE.—For abstract of bids see Duluth-Superior report.

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APPENDIX I I.

IMPROVEMENT OF RIVERS AND HARBORS ON WESTERN SHORE OF LAKE MICHIGAN.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1898, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Menominee Harbor, Michigan and Wisconsin.
2. Menominee River, Michigan and Wisconsin.
3. Oconto Harbor, Wisconsin.
4. Pensaukee Harbor, Wisconsin.
5. Green Bay Harbor, Wisconsin.
6. Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
7. Operating and care of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
8. Harbor of refuge at entrance of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
9. Ahnapee Harbor, Wisconsin.
10. Kewaunee Harbor, Wisconsin.
11. Two Rivers Harbor, Wisconsin.
12. Manitowoc Harbor, Wisconsin.
13. Sheboygan Harbor, Wisconsin.
14. Port Washington Harbor, Wisconsin.
15. Harbor of refuge at Milwaukee, Wis.
16. Milwaukee Harbor, Wisconsin.
17. South Milwaukee Harbor, Wisconsin.
18. Racine Harbor, Wisconsin.
19. Kenosha Harbor, Wisconsin.
20. Waukegan Harbor, Illinois.
21. Fox River, Wisconsin.
22. Operating and care of locks and dams on Fox River, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 9, 1898.

GENERAL: I have the honor to transmit herewith annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1898.

* * * * * * *

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

I I 1.

IMPROVEMENT OF MENOMINEE HARBOR, MICHIGAN AND WISCONSIN.

The original condition at the mouth of the Menominee River, object of the improvement, projects, and present works were described in detail in Annual Report, Chief of Engineers for 1896, pages 2459, 2460.

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Condition of the improvement.—The piers are built the full length contemplated; they are in fair condition, minor repairs only are now necessary. The channel has been dredged to the required depth of 17 feet and width of 200 feet.

Soundings taken June 4, 1898, showed that a shoaling of from 1 to 1½ feet had occurred in places since the dredged channel was completed. No material change in depth has occurred since that date. The actual depth June 30, 1898, was 16.5 feet.

Operations during the fiscal year.—By hire of labor and the use of U. S. dredge No. 2 dredging for the restoration of the channel was begun June 22, 1898, and during the remainder of the month 2,374 cubic yards of material was removed from the channel.

The renewal of 350 linear feet of the decking of the north pier, and other minor repairs to the piers, were begun June 23, 1898, and were in progress at the close of the fiscal year.

Remarks.—The dredging and repairs in progress will probably be completed in July, 1898.

For the maintenance of the channel and piers for the fiscal year ending June 30, 1900, the following estimate is recommended:

For dredging	$3,000
For repairs	2,000
For contingencies, 10 per cent	500
Total	5,500

Money statement.

July 1, 1897, balance unexpended	$3,897.52
June 30, 1898, amount expended during fiscal year	1,854.93
July 1, 1898, balance unexpended	2,042.59
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	5,500.00

Appropriations.

Act of—		Act of—	
March 3, 1871	$25,000	August 3, 1882	$15,000
June 10, 1872	25,000	July 5, 1884	10,000
March 3, 1873	25,000	August 5, 1886	3,000
June 23, 1874	25,000	August 11, 1888	9,000
March 3, 1875	25,000	August 18, 1894	10,000
August 14, 1876	8,000	June 3, 1896	7,150
June 18, 1878	10,000	Miscellaneous receipts credited to appropriations	62
March 3, 1879	10,000		
June 14, 1880	10,000	Total	229,212
March 3, 1881	12,000		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the collector of customs, Marquette, Mich.]

Name of harbor, Menominee, Mich.; collection district, Marquette, Mich.; nearest light-house, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam and sail	798	227,696	804	232,569

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Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

[Furnished by Mr. Isaac Stephenson, jr., and Messrs. Pemberthy, Cook & Co., Menominee, Mich.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Beer	35	Apples	225
Fish	200	Butter	10
Flour	59	Cattle	30
Lath	34,750	Cheese	5
Lumber	544,500	Coal and coke	3,500
Merchandise (general)	250	Eggs	2
Posts (fence)	133	Flour	215
Potatoes	5,460	Hay	2,500
Provisions	75	Merchandise (general)	3,500
Rye	524	Oats	2,800
Shingles	26,400	Salt	450
Wheat	600	Sugar	3,100
Total	612,926	Total	16,337
Total approximate value	$5,000,000	Total approximate value	$200,000

II 2.

IMPROVEMENT OF MENOMINEE RIVER, MICHIGAN AND WISCONSIN.

The original condition of the Menominee River, the object of the improvement, and the projects for carrying it out were fully described in the Annual Report of Chief of Engineers for 1896, page 2463.

Condition of the improvement.—The projects of 1890, 1892, and 1896 have been completed. Soundings taken through the ice in January, 1898, showed a shoaling of from 1 to 2 feet in places since the close of dredging, September 10, 1897. The governing depth in the channel January 8, 1898, was 16.5 feet below the datum plane of harbor improvements. It is probable that no material change in depth has occurred since that date. The actual depth June 30, 1898, was 16 feet.

Operations during the fiscal year.—Under contract dated October 14, 1896, with Mr. William A. Starke, of Milwaukee, Wis., for dredging 111,000 cubic yards, more or less, work was begun April 27, 1897, and to June 30 60,837 cubic yards were removed. The work was completed September 10, 1897, resulting in the removal of 58,583 cubic yards of material during the fiscal year, and a total of 119,420 cubic yards under this contract. Of this amount 13,973 cubic yards were hardpan and bowlders and 105,447 cubic yards sand, clay, etc.

The main channel was extended up the river 425 feet, and 5,000 linear feet of the channel was redredged at places where shoaling had occurred.

Remarks.—The depth of water in the channel is reduced by materials brought down the river during heavy spring freshets, rendering periodical dredging necessary to maintain the required depth.

For the maintenance of the channel an appropriation of $7,500 is recommended for the fiscal year ending June 30, 1900.

Original estimate (see House Ex. Doc. No. 34, Fifty-first Congress, first session)	$109,609.80
Revised estimate (see Report of Chief of Engineers, 1891, pp. 2529–2530).	74,500.00
Estimate for turning basin and extension of channel to Wells street (see Report of Chief of Engineers, 1896, p. 2464)	13,800.00

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Money statement.

July 1, 1897, balance unexpended	$11,123.86
June 30, 1898, amount expended during fiscal year	10,971.68
July 1, 1898, balance unexpended	152.18
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	7,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—	
September 19, 1890	$54,000.00
July 13, 1892	20,500.00
August 18, 1894	6,000.00
June 3, 1896	15,000.00
Miscellaneous receipts credited to appropriations	80.03
Total	95,580.03

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

The commercial statistics for the Menominee River are the same as for Menominee Harbor, Michigan.

II 3.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

The original condition of the Oconto River, the object of its improvement, the projects for carrying it out, and present works were described in detail in Annual Reports of Chief of Engineers for 1896, page 2465, and 1897, page 2653.

Condition of the improvement.—Soundings taken June 18, 1898, showed the channel from the entrance to within 600 feet of Spies's mill to be not less than 60 feet wide and 9 feet deep, below the datum plane of harbor improvements. No material change in depth has occurred since that date. The actual depth June 30, 1898, was 8.5 feet.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1898.

Remarks.—The channel should be widened 40 feet in order to obtain the required width of 100 feet. To give the north pier the length contemplated it should be extended 875 feet. Three hundred and twenty feet of the north pier (damaged by fire) and 300 feet of the south pier require immediate repairs. The remainder of the piers are of frail and cheap construction and will soon require extensive repairs.

The estimate for repairs needed to the piers, $3,100, and annual dredging for maintenance of the channel, $6,000, added to $37,610 for completion, make the aggregate estimate $46,710.

The estimate, therefore, for the fiscal year ending June 30, 1900, is—

For completion of modified project of 1897	$37,610
For repairs to piers	3,100
For maintenance of channel	6,000
Total	46,710

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Money statement.

July 1, 1897, balance unexpended	$154.88
June 30, 1898, amount expended during fiscal year	122.33
July 1, 1898, balance unexpended	32.55
Amount (estimated) required for completion of existing project	37,610.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, including $9,100 for maintenance	46,710.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—		Act of—	
March 3, 1881	$10,000	July 13, 1892	$3,000
August 2, 1882	15,000	August 18, 1894	3,000
July 5, 1884	15,000	June 3, 1896	4,000
August 5, 1886	8,000		
August 11, 1888	20,000	Total	78,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Oconto, Wis.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest lighthouse, Sherwood Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	525	26,050	525	26,050
Sail	105	10,500	105	10,500
Total	630	36,550	630	36,550

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Fish	1,500	Agricultural implements	26
Lath	633	Apples	75
Lumber	17,250	Brick	1,000
Peas	300	Coal and coke	2,000
Poles (telegraph)	17,000	Hay	200
Saw logs	18,000	Lime and cement	145
Shingles	900	Oil	225
Ties (railroad)	2,100	Salt	900
Wood	5,000	Stone	49,000
Total	62,683	Total	53,570
Total approximate value	$536,000	Total approximate value	$140,000

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Principal articles of export and import.—Continued.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	263	Agricultural implements	250
Barley	470	Apples	375
Beans	180	Beer	350
Beer	525	Brick	2,000
Cattle	150	Butter	20
Corn	366	Chairs	50
Fish	3,000	Cheese	5
Flour	430	Coal and coke	1,000
Hay	2,500	Corn	168
Hides	100	Eggs	22
Lath	4,950	Flour	1,290
Lumber	75,000	Furniture	440
Oats	3,072	Hay	600
Peas	600	Iron and steel	600
Poles (telegraph)	24,000	Lime and cement	725
Posts (fence)	7,600	Lumber	7,500
Potatoes	2,250	Merchandise (general)	15,000
Rye	112	Mill stuffs	5,000
Saw logs	18,000	Oats	3,200
Shingles	1,800	Oil	450
Ties (railroad)	4,200	Plaster (land)	250
Wheat	180	Pork and beef	720
Wood	12,500	Provisions	1,000
Wool	8	Salt	1,500
		Sash, doors, and blinds	100
		Saw logs	27,000
		Stone	7,000
		Wagons and carriages	250
		Wheat	48
		Wood	5,000
		Woodenware	175
Total	172,256	Total	82,088
Approximate value	$1,727,700	Total approximate value	$1,179,100

II 4.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

The original condition of the mouth of Pensaukee River, object of the improvement, project, and piers built to June 30, 1896, were described in detail in Annual Report of the Chief of Engineers for 1896, page 2468.

Condition of the improvement.—About 400 feet of the outer end of the pier was reported by Capt. R. G. Livermore to have been carried away March 24, 1898, by ice floes. An inspection made June 14, 1898, showed the report to be substantially correct, the outer 50 feet being considerably injured, the adjacent 250 feet entirely carried away, and the adjoining 100 feet so seriously injured that entire renewal would be necessary to put it in good condition. For a width of about 25 feet, the governing depth in channel was about 5 feet.

Operations during the fiscal year.—There were no operations at this harbor during the fiscal year.

Remarks.—Some dredging was done by private parties in 1895. No dredging has ever been done at this harbor by the United States, except 5,698 cubic yards during fiscal year ending June 30, 1884.

There appears to be no prospect of any new industries being located at this harbor, and there is no one there, except those engaged in or interested in fishing, to the number of twelve or fourteen persons, who seems to take any interest in the harbor.

It is considered that the funds available will be sufficient to make

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any repairs and do any dredging that may be necessary during the fiscal year ending June 30, 1900, and no further appropriation is recommended.

No arrivals and departures of vessels were reported at this harbor for the calendar year ending December 31, 1897.

Money statement.

July 1, 1897, balance unexpended	$1,000.00
July 1, 1898, balance unexpended	1,000.00

Appropriations.

Act of—	
August 2, 1882	$10,000
July 5, 1884	5,000
June 3, 1896	1,000
Total	16,000

II 5.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Fox River near its mouth constitutes the harbor of Green Bay. Its original condition, object of improvement, projects, and present works were described in detail in Annual Report of the Chief of Engineers for 1896, pages 2469, 2470, and 1897, pages 2657, 2658.

Condition of the improvement.—The revetments at Grassy Island are in fair condition. Soundings taken through the ice in February, 1898, showed that, with the exception of a number of small and unimportant shoal places, the channel had the required depth of 17 feet below the datum plane of harbor improvements.

From the mouth of Fox River to the north side of Grassy Island, a distance of 7,800 feet, the width is 200 feet; thence 6,000 feet to Sable Point Bar, 220 feet wide; thence 2,500 feet through Sable Point Bar it gradually increases to a width of 500 feet. It is probable that no material change in depth has occurred since that date. The actual depth June 30, 1898, was 16.5 feet.

Fox River, below Depere.—At the close of dredging August 2, 1897, the channel had a depth of 15 feet below the datum plane for harbor improvements for a width of about 100 feet. Soundings taken through the ice in January, 1898, indicated that shoaling had occurred in places reducing the governing depth to about 14 feet. It is probable that no material change in depth has occurred since then. The actual depth June 30, 1898, was 13.5 feet.

Operations during the fiscal year.—Under contract with the Racine Dredge Company, of Racine, Wis., dated October 14, 1896, for dredging 250,000 cubic yards, more or less, work was begun June 1, 1897, and completed September 29, 1897. The total number of cubic yards of material removed under this contract was 289,826, of which amount 245,216 cubic yards was removed during the fiscal year.

By hire of labor and purchase of materials in accordance with law minor repairs were made to the revetments at Grassy Island.

Fox River, below Depere.—Under contract dated May 14, 1897, with Mr. Arthur H. Vogel, of Milwaukee, Wis., for dredging 45,000 cubic

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yards of material, more or less, for improving Fox River below Depere, work was begun June 2, 1897, and completed August 2, 1897. The total number of cubic yards dredged under this contract was 44,319. Of this amount 26,384 cubic yards was excavated during the fiscal year.

Remarks.—To correct an error that occurred in the enrollment of act of June 3, 1896, the sum of $5,000 was appropriated for this improvement by act of July 19, 1897. The project of 1892, modified in 1897, for the improvement of Green Bay Harbor, is practically completed. Periodical dredging will be required for its maintenance.

The estimate submitted in 1897 for obtaining a channel 150 feet wide and 17 feet deep in Fox River below Depere was $30,000. A revised estimate, based upon a survey made in January, 1898, and soundings then taken through the ice, reduces the former estimate $8,000. The estimate submitted to complete the work is therefore $22,000.

Estimate for fiscal year ending June 30, 1900.

For dredging 50,000 cubic yards to maintain Green Bay channel, at 10 cents	$5,000	
For repairs to revetments at Grassy Island	1,000	
Contingencies, 10 per cent	600	
		$6,600
Fox River, below Depere:		
For completing channel by dredging 200,000 cubic yards, at 10 cents	20,000	
Contingencies, 10 per cent	2,000	
		22,000
Total		28,600

Money statement.

July 1, 1897, balance unexpended	$25,462.38
Appropriated by act of July 19, 1897	5,000.00
	30,462.38
June 30, 1898, amount expended during fiscal year	27,308.62
July 1, 1898, balance unexpended	3,153.76
Amount (estimated) required for completion of existing project	*22,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, including $6,600 for maintenance	28,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

Act of—		Act of—	
June 23, 1866	$30,500.00	August 2, 1882	$20,000.00
March 2, 1867	45,000.00	July 5, 1884	10,000.00
July 25, 1868 (allotted)	17,500.00	August 5, 1886	7,000.00
April 10, 1869 (allotted)	44,550.00	August 11, 1888	10,000.00
July 11, 1870	17,500.00	September 19, 1890	10,000.00
March 3, 1871	17,500.00	July 13, 1892	25,000.00
March 3, 1873	20,000.00	August 18, 1894	25,000.00
June 23, 1874	10,000.00	June 3, 1896	25,000.00
March 3, 1875	10,000.00	July 19, 1897	5,000.00
August 14, 1876	8,000.00	Miscellaneous receipts credited to appropriations	52.50
June 18, 1878	5,000.00		
March 3, 1879	4,000.00		
June 14, 1880	6,000.00	Total	377,602.50
March 3, 1881	5,000.00		

*For dredging Fox River below Depere, Wis.

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COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. Charles B. Roberts, collector of customs, port of Milwaukee, Wis.]

Name of harbor, Greenbay, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	391	196,965	391	191,892
Sail	198	42,348	197	39,413
Total	589	239,313	588	231,305

Principal articles of export and import for 1896.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Barley	18,200	Agricultural implements	245
Brick	507	Apples	1,184
Butter	⅝	Beer	17
Cattle	37	Cattle	38½
Cheese	2,524½	Cement	402½
Corn	600	Cheese	27½
Fish	911½	Coal and coke	170,311
Flour	19,832	Fish	1,078½
Hay	4,783	Furniture	13½
Hides	25	Hay	15
Hogs	6	Iron and steel	3,800
Malt	1,000	Marble	120
Merchandise (general)	92,423	Merchandise (general)	149,276
Mill stuffs	5,697	Oil	463½
Oats	35,312	Plaster (land)	434
Oil	67½	Pork and beef	180
Pease	6,000	Posts (fence)	323½
Pork and beef	8½	Rye	173½
Potatoes	125½	Salt	9,180
Rye	14,000	Shingles	99½
Salt	53½	Wagons and carriages	18½
Wheat	9,000	Wood	14,690
Wool	82		
Total	211,195½	Total	352,096½

NOTE.—Repeated efforts were made to obtain the commercial statistics of Greenbay Harbor for the calendar year ending December 31, 1897, but without avail.

II 6.

IMPROVEMENT OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

The original condition, object of the improvement, project, and present works were described in detail in Annual Report of the Chief of Engineers for 1896, pages 2471 and 2472, and, 1897, page 2660.

Condition of the improvement.—For a distance of 6,849 feet on the north side and 6,200 feet on the south side, measuring from the east or lake end, the canal banks are protected by revetments.

June 30, 1898, the governing depth in the channel was about 15 feet

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below the datum plane of harbor improvements, being about 0.9 of a foot more than at the beginning of the fiscal year.

Operations during the fiscal year.—By hire of labor and the use of the Government dredge and pile driver, and the purchase of materials in accordance with law, the north revetment was extended 694 linear feet and the south revetment 1,085 linear feet, completing the former to station 68½ and the latter to station 62.

Forty-four thousand one hundred and sixty-five cubic yards of material was excavated in widening the canal during the fiscal year.

Remarks.—The importance of the canal as a great maritime waterway is abundantly demonstrated by the great increase in commerce passing through the same since its purchase by the United States, April 25, 1893. The commerce passing through the canal during the calendar year ending December 31, 1897, was much greater than that of any previous year since its purchase by the Government, and was more than 100 per cent in excess of that passing through the last year it was owned by private parties.

It is therefore very essential that the present project for widening both the canal and the channel in Sturgeon Bay be completed as soon as the necessary funds for the improvements are provided.

The estimated cost of project adopted in 1894 (see Report of Chief of Engineers, 1894, page 2057) was		$98,450
Additional estimate, modified project of 1896:		
Increasing width of westerly 1,000 feet of canal to 250 feet	$4,750	
Increasing width of channel in Sturgeon Bay to 200 feet	10,300	
Total additional estimate		15,050
Total		113,500
Total appropriations, exclusive of purchase		50,000
Amount (estimated) to complete present project		63,500

An appropriation of $63,500 is recommended for the fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$16,083.50
June 30, 1898, amount expended during fiscal year	15,517.48
July 1, 1898, balance unexpended	566.02
July 1, 1898, outstanding liabilities	246.60
July 1, 1898, balance available	319.42
Amount (estimated) required for completion of existing project	63,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	63,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—	
July 13, 1892 (for purchase)	$81,833
August 18, 1894	20,000
June 3, 1896	30,000
Total	131,833

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COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. Adam N. Dier, superintendent Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.]

Name, Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, entrance to harbor.

Arrivals and departures of vessels.

Class.	Bound down.		Bound up.		Total.	
	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.
Steam	1,108	383,991	1,020	338,174	2,128	722,165
Sail	818	147,356	734	150,399	1,552	297,755
Unrigged	357	333,295	377	332,766	734	666,061
Total	2,283	864,642	2,131	821,339	4,414	1,685,981

Navigation through the canal for the season of 1897 was resumed April 12, the date on which the ice in Green Bay disappeared, and was practically closed December 22, the active or open season being, therefore, 254 days long.

Average number of craft passing through the canal per day for the whole season (not including tugs)	17.33
Average number of net tons passing through the canal per day for the whole season (not including tonnage of tugs)	6,637.76
Average net tonnage of steam craft	339.83
Average net tonnage of sail craft	191.85
Average net tonnage of unrigged craft	907.44

Among the larger class of boats passing through the canal during the past season were the steamers *Maryland, Manhatten, Manchester, Progress, Phenix, Cuba, Russia, J. F. Eddy, S. J. Murphey, Florida, R. P. Flower, St. Lawrence, Ann Arbor,* and others, whose net tonnage was 1,000 tons and more.

Statement of freight and passengers carried through the canal for the calendar year ending December 31, 1897.

Articles.	Net tons.	Articles.	Net tons.
BOUND DOWN.		BOUND UP.	
Agricultural implements	1,020	Bark	3,300
Apples	543	Brush	100
Cement	150	Coal	9,898
Coal	15,785	Dairy products	245
Fish	160	Fish	117
Flour	2,810	Flour	7,711
Glucose	985	Grain (all kinds)	5,050
Grains (all kinds)	5,303	Hay	250
Hay	718	Hides	174
Horses	12	Ice	300
Iron (manufactured)	2,982	Iron (manufactured)	150
Iron (pig)	30	Iron (pig)	6,090
Leather	470	Lath	1,423
Lumber	1,090	Logs	900
Merchandise (general)	35,592	Lumber	564,818
Oils	717	Merchandise (general)	5,511
Piles	102	Piles	965
Potatoes	337	Poles (telegraph)	14,262
Salt	18,698	Posts (fence and paving)	2,616
		Potatoes	1,953
		Salt	9
		Seed (flax)	704
		Shingles	3,060
		Stone (building and crib)	166,613
		Ties (railroad)	16,392
		Trees (shade and Christmas)	300
		Wood	42,670
		Wool	25
Total	87,999	Total	860,606
Passengers ....number..	5,426	Passengers ....number..	3,457

Total number of net tons of freight carried through canal during the calendar year ending December 31, 1897	948,605
Total number of passengers carried through the canal during the calendar year ending December 31, 1897	8,883

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Statement showing quantity and estimated value of freight carried through the canal for the calendar year ending December 31, 1897.

Items.	Quantity.	Price per unit.	Total valuation.
Agricultural implements ..... tons ..	1,020	$150.00	$153,000.00
Apples ..... barrels ..	7,240	4.00	28,960.00
Bark ..... cords ..	2,180	6.00	13,080.00
Brush ..... bundles ..	1,000	1.50	1,500.00
Cement ..... tons ..	150	20.00	3,000.00
Coal ..... do	25,683	3.50	89,890.50
Dairy products ..... do	245	150.00	36,750.00
Fish ..... do	277	100.00	27,700.00
Flour ..... barrels ..	100,210	5.50	551,155.00
Glucose ..... tons ..	958	30.00	29,550.00
Grain:			
Corn ..... bushels ..	161,700	.40	64,680.00
Peas ..... do	75,000	.90	67,500.00
Wheat ..... do	110,882	.95	105,337.90
Hay ..... tons ..	963	10.00	9,630.00
Hides ..... do ..	174	100.00	17,400.00
Horses ..... number ..	16	100.00	1,600.00
Ice ..... tons ..	300	3.00	900.00
Iron:			
Manufactured ..... do	3,132	50.00	156,600.00
Pig ..... do	6,039	18.00	108,702.00
Lath ..... thousand ..	5,175	2.00	10,350.00
Leather ..... tons ..	470	150.00	70,500.00
Logs ..... M feet B. M ..	300	12.00	3,600.00
Lumber ..... do	377,272	15.00	5,659,080.00
Merchandise (general) ..... tons ..	41,103	150.00	6,165,450.00
Oils ..... barrels ..	4,098	10.00	40,980.00
Piles ..... number ..	1,067	3.50	3,734.50
Poles (telegraph) ..... do	83,895	1.50	125,842.50
Posts (fence and paving) ..... do	137,668	.12	16,522.56
Potatoes ..... barrels ..	31,004	2.00	62,008.00
Salt ..... do	124,715	.80	99,772.00
Seed (flax) ..... bushels ..	25,143	1.20	30,171.60
Shingles ..... thousand ..	53,740	1.50	80,610.00
Stone ..... tons ..	166,613	.90	149,951.70
Ties (railroad) ..... number ..	227,050	.20	45,410.00
Trees ..... do	3,000	.50	1,500.00
Wood ..... cords ..	17,068	4.00	68,272.00
Wool ..... tons ..	25	400.00	10,000.00
Total value	.....	.....	14,110,690,26

Comparative statement of principal items of commerce through the canal for the calendar years 1896 and 1897.

Items.	Year.		Increase.	Decrease.
	1896.	1897.		
Vessels ..... number ..	4,031	4,414	383	.....
Tonnage ..... tons ..	1,558,143	1,685,981	127,838	.....
Tonnage (cargo) ..... do	831,370	948,605	117,235	.....
Passengers ..... number ..	9,700	8,893	.....	807
Agricultural implements ..... tons ..	1,767	1,020	.....	747
Apples ..... barrels ..	10,450	7,240	.....	3,210
Bark ..... cords ..	609	2,180	1,571	.....
Coal and coke ..... tons ..	30,162	25,683	.....	4,479
Fish ..... do	799	277	.....	522
Flour ..... barrels ..	92,350	100,210	7,860	.....
Grain (all kinds) ..... bushels ..	372,454	347,582	.....	24,872
Hay ..... tons ..	1,272	963	.....	309
Iron (manufactured) ..... do	10,409	3,132	.....	7,277
Iron (pig) ..... do	6,525	6,039	.....	486
Leather ..... do	100	470	370	.....
Lumber ..... M feet B. M ..	346,836	377,272	30,436	.....
Merchandise (general) ..... tons ..	43,628	41,103	.....	2,525
Oils ..... barrels ..	7,650	4,098	.....	3,552
Poles (telegraph) ..... number ..	84,946	83,895	.....	1,051
Posts (fence and paving) ..... do	57,455	137,668	80,213	.....
Potatoes ..... barrels ..	10,350	31,004	20,654	.....
Salt ..... do	105,235	124,715	19,480	.....
Seed (flax) ..... bushels ..	.....	25,143	25,143	.....
Shingles ..... M ..	.....	53,740	53,740	.....
Stone ..... tons ..	60,189	166,613	106,424	.....

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Comparative statement of principal items of commerce through the canal for the calendar years 1896 and 1897—Continued.

Items.	Year.		Increase.	Decrease.
	1896.	1897.		
Ties (railroad).....number..	348,859	227,050	.....	121,809
Trees (shade and Christmas).....do....	48,000	3,000	.....	45,000
Wood.....cords..	18,259	17,068	.....	1,191

Estimated value of freight passing through canal during the calendar year ending December 31, 1896	$14,224,429.85
Estimated value of freight passing through canal during the calendar year ending December 31, 1897	14,110,690.26
Decrease in value of freight in 1897 as compared with 1896	113,739.59

Statement showing number and net tonnage of tugs passing through the canal during the calendar year ending December 31, 1897, and the number of vessels and scows towed during that time.

Month.	Bound down.				Bound up.			
	Number.	Net tons.	Vessels towed.	Scows towed.	Number.	Net tons.	Vessels towed.	Scows towed.
April	48	1,602	8	18	49	1,601	8	22
May	118	3,339	51	81	123	3,466	39	36
June	107	2,830	23	41	104	2,774	39	43
July	100	2,590	29	50	97	2,458	43	50
August	105	2,860	27	67	104	2,843	31	67
September	120	3,519	44	53	122	3,507	52	53
October	144	3,361	44	36	123	3,530	57	39
November	111	3,285	29	21	117	3,457	41	24
December	31	810	.....	14	32	786	8	11
Total	884	24,245	264	331	871	24,422	318	360

Total number of trips made through canal by tugs for whole season	1,755
Total number of net tons	48,667
Total number of vessels towed	583
Total number of scows towed	691
Total number of vessels and scows towed	1,273
Average net tonnage of tugs	27.73
Average number passing through canal per day for whole season	6.93
Number of tugs stationed at canal engaged in local towing	7
Net tonnage of tugs stationed at canal for local towing	190
Length of towing route from harbor entrance to mouth of Sturgeon Bay, miles	8½

Statement of class and tonnage of vessels coming in from the lake, via the canal, during the season of 1897, to seek shelter in Sturgeon Bay from storms.

Month.	Steam.		Sail.		Unrigged.		Total.	
	No.	Net tons.	No.	Net tons.	No.	Net tons.	No.	Net tons.
January	4	3,920	.....	.....	.....	.....	4	3,920
February	2	2,292	.....	.....	.....	.....	2	2,292
March	1	801	.....	.....	.....	.....	1	801
April	4	1,602	1	75	3	1,100	8	2,777
May	11	3,750	10	1,454	2	1,000	23	6,204
June	5	1,113	6	264	.....	.....	11	1,377
July	3	1,874	2	116	.....	.....	5	1,990
August	4	332	11	965	4	1,200	19	2,497
September	6	1,561	17	2,045	2	1,763	25	5,369
October	20	6,540	25	4,470	.....	.....	45	11,010
November	21	5,243	28	9,663	5	1,500	54	16,406
December	9	2,352	3	1,887	7	7,152	19	11,391
Total	90	31,380	103	20,939	23	13,715	216	66,034

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No record was kept of those craft bound out detained at Sturgeon Bay by stormy weather, though at times during the spring and fall months the outbound fleet thus sheltered numbered as high as forty craft, not including those that came in from the lake via the canal to seek a harbor of refuge in this bay.

Craft hailing from nearly every principal port on the chain of lakes could be found among those that sought the shelter of this harbor during severe storms, the natural land-locked bay offering perfect protection and safety to craft whichever direction the wind may blow from.

The mooring facilities in Sturgeon Bay are at present not such as could be desired for so perfect a harbor in every other respect, sheltered craft being obliged to come to anchor in or near the regularly used channel on account of the shoal water elsewhere. This greatly interferes with the free navigation of the bay, and there is constant danger of collisions between craft in transit and those moored in the bay for shelter.

To overcome this difficulty, a basin of ample area should be dredged at the head of Sturgeon Bay where craft in for shelter could be provided with moorage and placed in a systematic way so that the channel used by those in transit would in no way be obstructed through this source.

Such an arrangement would add vastly to the importance of Sturgeon Bay as a harbor of refuge, and vessel men would not fail to appreciate the opportunity offered to safely shelter their craft during storms.

Sturgeon Bay has a coaling station, weather-display station, telegraph and long-distance telephone facilities, all of which are necessary adjuncts to a first-class harbor of refuge.

Average net tonnage of steam craft sheltered	348.75
Average net tonnage of sail craft sheltered	209.39
Average net tonnage of unrigged craft sheltered	600.15

The past season having been singularly free from severe and protracted storms, the number of craft seeking the shelter of this harbor was not as great as in former years when storms were more prevalent and protractive.

Class, quantity, and estimated value of cargoes carried by vessels sheltered in Sturgeon Bay, season of 1897, only those coming in from the lake via the canal being included.

Items.	Quantity.	Price per unit.	Total valuation.
Apples.....barrels..	600	$4.00	$2,400.00
Bark.....cords..	330	6.00	1,980.00
Coal.....tons..	6,127	3.50	21,444.50
Grain:			
Peas.....bushels..	2,000	.90	1,800.00
Wheat.....do....	1,000	.95	950.00
Hay.....tons..	580	10.00	5,800.00
Iron:			
Manufactured.....do....	25	50.00	1,250.00
Pig.....do....	1,450	18.00	26,100.00
Leather.....do....	30	150.00	4,500.00
Lumber.....M. feet B. M..	11,235	15.00	168,525.00
Merchandise (general).....tons..	662	150.00	99,300.00
Poles (telegraph).....number..	825	1.50	1,237.50
Posts (fence and paving).....do....	8,500	.12	1,020.00
Potatoes.....barrels..	1,200	2.00	2,400.00
Salt.....do....	9,000	.80	7,200.00
Ties (railroad).....number..	3,200	.20	640.00
Wood.....cords..	2,486	4.00	9,944.00

Total estimated value of cargoes	$356,491
Total approximate value of vessels sheltered	4,380,600
Approximate value of vessels and cargoes	4,737,091

The valuation of vessel property seeking shelter in Sturgeon Bay via the canal during the past season, as given above, is based on the valuation given in Lloyd's Vessel Register, and is approximate.

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Principal lines of transportation using the canal during the past year and number and net tonnage of boats comprising each line.

Name of line.	Home port.	Number of boats.	Net tonnage.
Toledo, Ann Arbor and Northern Michigan R. R., freight and passengers.	Toledo, Ohio	2	2,292
Lake Michigan Car Ferry Transportation Co., freight.	Chicago, Ill	6	6,874
Goodrich Transportation Co., freight	do	7	5,398
Manistee Transportation Co., freight and passengers.	Manistee, Mich	2	1,277
Stephenson Transportation Co., freight	Chicago, Ill	6	2,134
Spalding Lumber Co., freight	do	6	1,563
Leathem & Smith Towing and Wrecking Co., freight	Sevastopol, Wis	12	3,899
Two Rivers Manufacturing Co., freight	Two Rivers, Wis	3	677
Hamilton & Merryman Co., freight	Marinette, Wis	3	956
Hausler & Lutz Co., freight	Chicago, Ill	3	1,100
John Schrooder Lumber Co., freight	Milwaukee, Wis	3	699
Total		52	26,869

In addition to the above regular lines of transportation a large number of steam barges, sail vessels, and scows engaged in the general freighting business use the canal continually, going both ways, during the navigation season, and a large local business is done by tugs engaged in assisting sail vessels, scows, etc., through the canal. The establishment of the Lake Michigan Car Ferry Transportation line between South Chicago and Peshtigo, via the canal, has added very largely to the commercial importance of the waterway.

II 7.

OPERATING AND CARE OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

Operations have been confined to work incident to operating and care, examinations, keeping a record of vessels and tonnage through the canal, and such dredging and repairs as were necessary for maintenance.

For details of work done during the year see report of Mr. Adam N. Dier, superintendent of the canal, appended to this report.

The expenditures during the year ending June 30, 1898, amounted to $15,037.58 from an allotment from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended hereto.

Money statement.

July 1, 1897, balance unexpended	$2,544.60
Amount allotted for fiscal year ending June 30, 1898	12,873.77
	15,418.37
June 30, 1898, amount expended during fiscal year	15,037.58
July 1, 1898, balance unexpended	380.79
July 1, 1898, outstanding liabilities	374.50
July 1, 1898, balance available	6.21
Amount (estimated) for expenditure in fiscal year ending June 30, 1899	* $27,435.79
Amount available for fiscal year ending June 30, 1899	27,442.00

*Amount allotted if estimate is approved.

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REPORT OF MR. ADAM N. DIER, SUPERINTENDENT STURGEON BAY AND LAKE MICHIGAN SHIP CANAL.

UNITED STATES ENGINEER OFFICE,
Sturgeon Bay, Wis., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations upon "Operating and care of canals and other works of navigation" as applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin, for the fiscal year ending June 30, 1898:

The work accomplished during the year consisted principally in entire renewal of the most dilapidated sections of the canal revetments and repairs to other portions of the works; dredging for maintenance of channel; making the necessary surveys to ascertain the condition of the channel; repairs of the pile-driving plant; building a new watch house near westerly end of the canal; care and preservation of grounds and buildings, and other work incidental to operating and care, such as supervision of the works and the improvements in progress, collecting commercial statistics, night service, etc.

MAINTENANCE OF NAVIGATION.

Navigation through the canal for the year 1897 was opened April 12 and practically closed December 22, the active or open season being, therefore, 254 days.

Navigation through the canal for the season of 1898 was resumed with the disappearance of the ice in Green Bay, April 4.

The commerce passing through the canal during the calendar year ending December 31, 1897, was the greatest in the history of the canal, and was more than 100 per cent in excess of that of the year immediately preceding the transfer of the waterway to the United States.

CONDITION OF CHANNELS.

The depth of water in the canal and its approaches was well maintained throughout the year, and no serious groundings occurred in the channels.

The water reached its minimum stage during the year at 6 o'clock p. m. of January 2, 1898, when it was 2.85 feet below the zero mark, or 5.91 feet below high water mark of 1838, and the maximum stage was recorded at 4 o'clock p. m. of June 3, 1898, when the tide gauge showed it to be .80 foot below the zero mark, or 3.86 feet below high-water mark of 1838.

RENEWAL AND REPAIRS OF CANAL REVETMENTS.

The United States owning a dredging and pile-driving plant, all improvements to the works during the year were accomplished by hire of labor and purchase of materials in accordance with law.

The old revetment on north side of the canal, westerly from the slip near the lake end of the works, was in such an advanced state of decay and in such dilapidated condition as to require entire renewal. The old revetment was accordingly taken up, the slip extended westward about 500 linear feet and new revetment of "Wakefield" patent triple-lap sheet piling put in, a total of 543 linear feet being constructed to revet the extension to the slip, including the end of the offset. Work of excavating for the extension to the slip was commenced August 2, 1897, and pile driving begun the 16th of the same month, and the improvement completed September 25, 1897. The space behind the new work was filled to the water surface with sand washed down from the high banks with the pump on the pile driver, an estimated total of 2,700 cubic yards of material being thus washed into the space. The cost of the new revetment at this place, exclusive of the dredging, was $6.19 per linear foot, of which sum $4.30 was for materials, $1.64 for labor, and $0.25 for royalty.

Similar improvements were made in front of the office premises during the months of May and June, 1898, where 400 linear feet of the old revetment was taken up and entirely renewed with the sheet-pile revetment of the "Wakefield" triple-lap pattern. Work on this improvement was commenced May 1, 1898, when the dredge began excavating a slip so that the new revetment could be set back on a line conforming with the new work at the easterly and westerly ends of the canal; pile driving was commenced June 7 and completed June 30. A total of 466 linear feet of new revetment was constructed at this place at a cost of $5.56 per linear foot, of which sum $3.55 was for materials, $1.76 for labor, and $0.25 for royalty.

The minor repairs made to the canal revetments during the year consisted of renewing a large number of broken and unserviceable water wales, caps, and bind-

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ers, and refastening many of the old caps and binders with new screw bolts. The following repair work was accomplished during the year:

North revetment.—On this side of the canal, between Stations 14 and 44, 474 linear feet of new 12 by 12 inch white-pine water wale, 42 linear feet of new 12 by 12 inch white-pine cap timber, and 24 linear feet of new 3 by 12 inch white-pine binders were used in replacing old, broken, and unserviceable materials. This timber was fastened in place with 58 iron tie-rods, 1¼ inches by 17 feet, and 26 new screw bolts, 1¼ inches by 27¼ inches.

South revetment.—On this side of the canal, between Stations 17 and 34, 1,185 linear feet of new 12 by 12 inch white-pine water wale and 160 linear feet of new 3 by 12 inch white-pine binders were used in replacing old, broken, and unserviceable materials. This timber was fastened in place with 173 iron tie-rods, 1¼ inches by 17 feet, and 91 new screw bolts, 1¼ inches by 27¼ inches. One hundred and seventy-two linear feet of the old caps and binders on this side of the works were refastened with 43 new screw bolts, 1¼ inches by 27¼ inches.

The cluster of protection piles at the southeast corner of harbor entrance to canal was further strengthened by the addition of five round piles and by binding the whole clump firmly together with four turns of heavy chain.

Dredging operations.—The following dredging for maintenance of channel was done during the fiscal year: During the months of July, August, and September, 1897, 20,279 cubic yards of material was removed, of which quantity 12,626 cubic yards were removed in extending the slip on north side of canal near lake end, 1,978 cubic yards in front of this slip, and 5,675 cubic yards in extending the south cut from Station 40 to Station 51½. Dredging on this cut was resumed May 24, 1898, since which time 15,665 cubic yards have been removed, making a total of 35,944 cubic yards removed during the fiscal year.

Surveys and soundings.—A survey was made in August, 1897, of the rock underlaying the bottom of the canal between Stations 0 and 3, and its depth below the zero mark of the tide gauge determined at Stations 0, ½, 1, 2, and 3.

January, 1898, a survey was made of the easterly portion of Sturgeon Bay and soundings taken through the ice from Station 72 to Station 122. Soundings were taken on transverse lines 50 feet apart, at intervals of 50 feet excepting in the channel and below the "Angle" light, where they were taken at intervals of 25 feet. The area covered by these soundings measured 500 feet in width and extended into Sturgeon Bay 5,000 feet beyond the canal limits.

March, 1898, the usual spring soundings were taken in the canal from Station 0 to Station 72. These soundings were taken on transverse lines 100 feet apart, at intervals of 20 feet as heretofore.

Repairs of pile-driving plant.—Early on the morning of August 28, 1897, the pile-driving plant, which was moored at westerly end of the slip, on north side of canal, near lake end, was run into by Car Ferry No. 1, in tow of the tug *S. M. Fischer*, and badly damaged. The flat scow was badly twisted and forced upon the anchor piling of the revetment then in course of construction, and two planks in the rake of the scow were stove in, causing it to leak so badly that it was difficult to keep it afloat until the driver could be taken off. The suction and standpipe of the steam pump were destroyed and other damage done to the plant. The driver was transferred to the bank and the scow taken to the shipyard for repairs. The whole outfit was repaired in first-class shape and operations on construction of revetment resumed September 5. April, 1898, the flat scow and driver were repainted and some minor repairs made to the machinery, carriage, and Worthington steam pump.

New watch house.—A small building was constructed near Station 62 on the northerly side of the canal to serve the purpose of a watch house for the man stationed at the westerly end of the canal during the night. The building is of frame, with ground dimensions of 12 by 14 feet, with 12-foot walls and gable roof. The exterior is finished with drop siding and the inside ceiled with matched and beaded basswood lumber. The structure is provided with a suitable brick chimney and is neatly painted outside and inside. A platform was constructed in front of the building and a large locomotive headlight mounted for use of the watchman in getting the names of passing craft.

Care and preservation of grounds and buildings.—The following improvements were made to grounds and buildings: The remainder of the inclosed premises surrounding the office building and dwelling house were leveled off, a foot of good soil placed over same, and covered with a layer of live sod. The lands pertaining to the canal adjacent to the inclosed office premises were cleared of stumps, logs, and other rubbish to lessen danger from forest fires, and a huge bank of sand that had accumulated in the rear of the storage warehouse removed. Twenty shade and ornamental trees were planted on the office premises and a suitable plank walk put down between the office and the dwelling house. The height of the flag pole on the office premises was increased by the addition of a topmast, and a suitable structure and pole put

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up for mounting the anemometer. The outside of the storage warehouse, including the roof, was repainted, and some minor repairs made about the eaves of the building.

General supervision, etc.—General supervision was maintained over the works and the improvements in progress during the year. Complete and classified records of all craft passing through the canal during the year were carefully kept as usual. Also a classified record of those craft coming in from the lake via the canal to seek shelter in Sturgeon Bay from storms, together with a record of the class, quantity, and approximate value of the cargoes carried by them at the time they were thus sheltered. The reports of commercial statistics received were properly entered on the canal register and the necessary reporting, correspondence, and all other clerical work connected with the office attended to. During the open season the regular night service was maintained, which consisted of one watchman stationed at the lake end of the canal to the close of the season of 1897 and two watchmen, one stationed at each end of the canal, since April 1, 1898.

The rules and regulations governing the navigation and use of the canal were generally well observed and complied with by vessel men using the canal, only two apparently willful violations being recorded during the year. In one case the party was brought before the United States district judge at Milwaukee and plead guilty, the minimum fine being imposed, and the other case was reported to the United States district attorney for prosecution.

The widening of the canal at its westerly end has aided very materially in reducing the dangers of collision between craft in transit, though the numerous corners of the different offsets are considerable of a menace to vessels passing through, as a peculiar current effect is produced in the vicinity of these corners. Craft approaching these offsets are first drawn in toward the offset by the current and then, when the other corner is reached, are forced out the other way, and when the current is very strong it is quite difficult, and in many cases almost impossible, to prevent them from taking a sheer to one or the other side of the canal. Of course, this evil can only be overcome by making the canal of uniform width, on one side at least, and this is an imperative necessity as soon the required funds are provided.

(For commercial statistics for the calendar year ending December 31, 1897, see the statistics with report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin, for the fiscal year ending June 30, 1898.)

Remarks and recommendations.—The north revetment from harbor entrance to westerly end of the offset is in good condition and will require no repairs beyond 4 new water wales between Stations 0 and 3, unless damaged by craft in transit.

With the exception of the 400 feet of revetment in front of the office premises, which was rebuilt in 1898, the entire north revetment from westerly end of the slip near lake end of canal to the easterly end of new revetment constructed in 1895, should be rebuilt at once. Nearly all of this revetment was built in 1879 and 1880, and is in an advanced state of decay, its condition being such that it would be a waste of money to attempt to repair it. The distance between westerly end of slip and easterly end of new revetment of 1895 is about 3,100 feet, of which 400 feet has been rebuilt; thus leaving about 2,700 linear feet of revetment to rebuild. The remainder of the north revetment is in excellent condition, and will need no repairs unless damaged by craft in transit.

The south revetment, built in 1879, 1880, and 1889, is also in an advanced state of decay, but is in much better condition than that on the north side. It will last for some years to come, but annual repairs will be necessary to keep it in serviceable condition. This revetment was provided with over 2,000 linear feet of new 12 by 12 inch white pine water wale during the past two years, which strengthened it quite materially.

Additional riprap will be needed for shore protection of harbor front. The action of sea and ice makes it necessary to add more stone annually to keep this riprap and shore protection in serviceable condition.

In excavating for the slip in front of the office premises the improvements of the bank and terraces of the slope were obliterated, and the front now presents a very unsightly appearance. Other portions of the canal banks adjacent to the office premises should be cleared of logs, stumps, and other rubbish that is apt to be ignited by forest fires, which are still of frequent occurrence during the dry season of the summer months. The outside of the office building, dwelling house, storage warehouse, and the two watch houses will require repainting during the spring of 1899. Some papering and painting on the inside of the office building will also be required during the present year.

For the maintenance of the channel, annual dredging will be necessary as the needs of navigation demand.

It is respectfully recommended that the improvements as outlined above be authorized and carried into effect during the fiscal year ending June 30, 1899, if the required

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funds can be obtained, an estimate of the amount required for each improvement being given below.

ESTIMATES.

For services of superintendent, assistant superintendent and clerk, and two watchmen	$3,180.00
For supplies, fuel, etc	300.00
For care and preservation of grounds and buildings	900.00
For dredging for maintenance of channel, 40,000 cubic yards, at 8 cents per yard	3,200.00
Repairs of revetments	17,068.00
Riprap for exterior works, 60 cords, at $5	300.00
10 per cent for surperintendence and contingencies	2,494.80
Total	27,442.80

Very respectfully, your obedient servant,

ADAM N. DIER, *Superintendent.*

Capt. GEORGE A. ZINN,
Corps of Engineers, U. S. A.

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
July 7	1	Bishop & Brooks	Round piles	$420.00
15	2	Continental Bolt and Iron Works	Iron tie rods, etc	698.37
31	3	E. A. Cannon	Telegrams	.94
Aug. 2	1	Hired men	Services, July, 1897	289.08
5	2	H. H. West Co	Books	3.87
7	3	Ives Bros	Labor	5.65
31	4	Hired men	Services	680.00
31	5	E. A. Cannon	do	150.00
Sept. 1	1	Hired men	Services, August, 1897	574.46
7	2	The C. Reiss Coal Co	Coal	175.00
7	3	do	do	52.50
7	4	Scofield & Co	Rubber valves, etc	30.68
14	5	Edward Gillen	Traveling expenses	7.75
14	6	John Light	do	3.75
14	7	E. A. Cannon	do	5.95
14	8	Rieboldt, Wolter & Co	White-pine timber, etc	1,389.87
14	9	Western Union Telegraph Co	Telegrams	1.67
18	10	Menominee Iron Works Co	Cap block, etc	32.15
21	11	Scofield & Co	Hose, etc	69.45
21	12	Rieboldt, Wolter & Co	Oak timber, etc	268.44
25	13	Kohler, Hayssen & Stehn Manufacturing Co.	Brake bands	2.68
29	14	Scofield & Co	Iron, etc	27.20
29	15	J. S. Hay	Bolts, etc	14.60
30	16	E. A. Cannon	Traveling expenses	12.50
Oct. 1	1	Hired men	Services, September, 1897	1,102.71
7	2	Menominee Iron Works Co	Standpipe, etc	15.65
7	3	Des Forges & Co	Blank book, etc	2.40
16	4	E. A. Cannon	Traveling expenses	8.20
19	5	M. J. Schmitt	Tracing cloth	9.45
22	6	The Ludington, Wells & Van Schaick Co.	Pine timber	491.40
22	7	The C. Reiss Coal Co	Coal	35.00
29	8	Nick C. Nelson	Materials and labor	79.50
29	9	Scofield & Co	Paint, etc	53.00
29	10	J. S. Hay	Rope	8.06
29	11	Scofield & Co	Spikes, etc	33.30
Nov. 1	1	Hired men	Services, October, 1897	541.58
6	2	Wyckoff, Seamans & Benedict	Paper	2.70
20	3	do	Typewriter	92.25
23	4	M. J. Schmitt	Drawing paper	8.00
30	5	E. A. Cannon	Services	150.00
30	6	Scofield & Co	Spikes	8.50
30	7	N. S. Washburn & Co	White pine	9.22
30	8	Hired men	Services	412.08
Dec. 9	1	M. J. Schmitt	Blue prints, etc	12.40
31	2	G. K. Kendall	Paper, etc	3.05
31	3	Hired men	Services	415.85

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1898.				
Jan. 8	1	Scofield & Co	Paint, etc	$16.97
31	2	E. A. Cannon	Services	150.00
Feb. 3	1	Hired men	Services, January, 1898	267.08
28	2	W. P. Wagner	Rent of office	33.33
28	3	Hired men	Services	168.83
Mar. 31	1	.....do	.....do	308.00
31	2	.....do	.....do	154.33
Apr. 11	4	Frank Hamachek	Steel, iron, etc	123.94
28	2	Wakefield Sheet Piling Co	Royalty on sheet piling	127.50
30	3	Chas. Crosman	Services	200.00
30	4	J. A. B. Tompkins	.....do	150.00
30	5	N. S. Washburn & Co	Pine lumber, etc	69.59
30	6	J. S. Hay	Headlight	30.15
30	7	.....do	Nails, etc	22.25
May 4	1	Hired men	Services, April, 1898	536.91
14	2	Willer Manufacturing Co	Pine reel	8.50
14	3	Burdick, Armitage & Allen	Job printing	11.00
27	4	.....do	Paper	2.50
28	5	The C. Reiss Coal Co	Coal	280.00
31	6	E. A. Cannon	Services	150.00
31	7	Hired men	.....do	637.11
31	8	Scofield & Co	Valve springs, etc	32.00
31	9	Riebold, Wolter & Co	Pine timber and plank	1,083.85
June 10	1	Burdick, Armitage & Allen	Job printing	7.50
29	2	Hired men	Services	385.34
30	3	.....do	.....do	253.00
30	4	E. A. Cannon	.....do	150.00
30	5	Hired men	.....do	953.47
30	6	J. S. Hay	Sheaves, etc	16.19
30	7	.....do	Steel, etc	11.38
30	8	The C. Reiss Coal Co	Coal	280.00
30	9	Alex. Anderson	Cold shuts, etc	16.00
		Total		15,037.58

I I 8.

IMPROVEMENT OF STURGEON BAY CANAL, HARBOR OF REFUGE, WISCONSIN.

The original condition at this harbor, object of the improvement, projects, and present works were described in detail in Annual Report Chief of Engineers for 1896, pages 2481 and 2482.

Condition of the improvement.—The main and detached piers are of the full length contemplated. Soundings taken in March, 1898, showed a channel 17.5 feet deep below the datum plane of harbor improvements, with a width at entrance of about 180 feet, and minimum width at entrance to canal of about 80 feet. No material change in depth has occurred since that date. The actual depth June 30, 1898, was 17 feet.

Operations during the fiscal year.—By hire of labor and the use of U. S. dredge No. 2, 9,244 cubic yards of material were removed in deepening the channel during the month of July, 1897, since which time no dredging has been done.

By hire of labor, the use of the United States pile-driver plant, and purchase of materials in accordance with law, about 60 linear feet of the guide-fender piling connecting the main and detached piers on north side of the harbor was entirely renewed, this work being accomplished during the month of May, 1898. During the fall months of 1897 new protection piling was put in along the outer face of the detached pierheads, Cribs 10 and 11 of the south pier and a considerable portion of the main pier on the north side provided with new 3 by 12 inch

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white-pine covering plank, and 780 linear feet of new 8 by 12 inch white-pine binders put in to hold the tops of the sheet piling—with which a section of each main pier is provided—securely in place.

Remarks.—The main and detached harbor piers are in good condition, and, with the exception of new covering plank, will need no repairs during the ensuing fiscal year unless damaged by craft in transit. The guide-fender piling on both sides of the harbor, excepting the section on north side just renewed, is in a very advanced state of decay, and should be rebuilt as soon as the necessary funds are provided, the amount estimated that will be required to renew the remainder being $2,800.

It is also expected that some dredging for maintenance of the channel will be necessary during the present season and also on the opening of navigation in the spring of 1899, as considerable shoaling of the channel will no doubt take place between now and then.

Estimate for fiscal year ending June 30, 1900.

Dredging for maintenance of channel, 10,000 cubic yards, at 10 cents	$1,000
Renewal of 270 linear feet of fender piling	2,800
Renewal of decking and other minor repairs to piers	1,200
Contingencies, 10 per cent	500
Total	5,500

An appropriation of $5,500 for maintenance of existing works is recommended for fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$3,983.30
June 30, 1898, amount expended during fiscal year	2,688.35
July 1, 1898, balance unexpended	1,294.95
July 1, 1898, outstanding liabilities	137.16
July 1, 1898, balance available	1,157.79
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	5,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

Act of—		Act of—	
March 3, 1873	$40,000.00	September 19, 1890	$3,000.00
March 23, 1874	10,000.00	July 13, 1892	5,000.00
June 18, 1878	30,000.00	August 18, 1894	5,000.00
March 3, 1879	30,000.00	June 3, 1896	5,000.00
June 14, 1880	10,000.00	Miscellaneous receipts credited to appropriations	182.50
March 3, 1881	10,000.00		
August 2, 1882	20,000.00		
July 5, 1884	10,000.00		
August 5, 1886	5,000.00	Total	183,182.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

See the statistics with the report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

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II 9.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

The original condition of the mouth of Wolf River, object of the improvement, projects, and present works were described in detail in Annual Report Chief of Engineers for 1896, pages 2483, 2484, and 1897, page 2672.

Condition of the improvement.—The piers are built the full length contemplated, and are in fair condition. Soundings taken in May, 1898, showed a depth of 16 feet below the datum plane of harbor improvements at the harbor entrance and 13 feet at the shore end of the piers for a width of 60 feet. In the basin just inside the shore line the average depth is about 10 feet. No material change in depth has occurred since that date. The actual depth June 30, 1898, at the shore end of the piers was 12.5 feet.

Operations during the fiscal year.—By hire of labor, the use of U. S. dredge No. 2, and the purchase of materials in accordance with law, 12,543 cubic yards of material was removed from the channel. The dredging was begun October 11 and completed November 13, 1897. By the use of the United States pile driver the pierheads were protected by fender piling; minor repairs were also made to the decking and superstructure of the piers.

The original estimated cost of the present project (see Report of Chief of Engineers, 1876, Part II, pp. 346 and 359, and 1880, p. 1910), was	$175,000
Additional estimate (see Report of Chief of Engineers, 1891, p. 2539)	10,000
Additional estimate (see Report of Chief of Engineers, 1893, pp. 350 and 2722)	8,000
Total	193,000
Less total appropriations	183,220
Balance of estimate unappropriated	9,780
Estimated amount required for completion of present project, in addition to funds now available	15,000
Less unappropriated balance of estimate	9,780
Increase in estimate	5,220
Total estimated cost of present project	196,220

The increase in the estimate is due to the cost of maintenance of channel.

An appropriation of $15,000 for completion of present project is recommended for the fiscal year ending June 30, 1900.

It is proposed to do the dredging now needed during the present working season with funds now available.

Money statement.

July 1, 1897, balance unexpended	$6,979.82
June 30, 1898, amount expended during fiscal year	2,293.65
July 1, 1898, balance unexpended	4,686.17
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

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Appropriations.

Act of—		Act of—	
March 3, 1871	$25,000	August 5, 1886	$15,000
June 10, 1872	25,000	August 11, 1888	5,000
March 3, 1875	25,000	September 19, 1890	6,000
August 14, 1876	8,000	July 13, 1892	7,000
June 18, 1878	8,000	August 18, 1894	5,000
March 3, 1879	7,000	June 3, 1896	5,000
June 14, 1880	7,000	Miscellaneous receipts credited to appropriations	220
March 3, 1881	8,000		
August 2, 1882	12,000	Total	183,220
July 5, 1884	15,000		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Algoma, Wis. (Ahnapee Harbor).]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest lighthouse, on north pierhead, Ahnapee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	420	292,000	420	292,000
Sail	296	180,642	292	180,005
Total	716	472,642	712	472,005

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Bark (tan)	55	Agricultural implements	840
Barley	807	Apples	15
Butter	156½	Beer	31½
Cheese	493½	Chairs	8
Eggs	234½	Cheese	1½
Fish	190	Coal and coke	290
Flour	14	Corn	7
Furniture	266½	Fish	2½
Hay	1,812	Furniture	171½
Hides	40	Iron and steel	75
Marble	60	Lath	103
Oats	41½	Leather	7
Peas	13,811½	Lime and cement	56½
Posts (fence)	152	Lumber	330
Potatoes	1,089	Marble	75
Rye	436½	Merchandise (general)	8,000
Sheep	34½	Mill stuffs	60
Shingles	120	Oil	13½
Ties (railroad)	2,450	Pork and beef	24
Wheat	600	Provisions	350
Wood	5,000	Salt	525
Woodenware	291½	Sash, doors, and blinds	20
Wool	1½	Wagons and carriages	87½
		Woodenware	2
Total	27,157½	Total	11,089½
Total approximate value	$896,304	Total approximate value	$796,896

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Principal articles of export and import—Continued.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	28	Agricultural implements	1,060½
Apples	6	Apples	15
Barley	438½	Beer	1,099
Butter	203	Chairs	3
Cattle	856	Cheese	1½
Cheese	498½	Coal and coke	380
Eggs	25½	Corn	7
Fish	253	Fish	2½
Flour	58	Flour	137½
Furniture	322½	Furniture	91
Hay	12,680	Iron and steel	87½
Hides	40	Lath	103
Marble	65½	Leather	7
Oats	142½	Lime and cement	58
Peas	1,881½	Lumber	585
Posts (fence)	152	Marble	75
Potatoes	1,218	Merchandise (general)	1,000
Rye	549½	Mill stuffs	76
Sheep	18	Oil	216
Shingles	480	Pork and beef	27½
Ties (railroad)	2,940	Provisions	390
Wheat	900	Salt	525
Woodenware	204½	Sash, doors, and blinds	23
Wool	13	Saw logs	360
		Sheep	3,800
		Shingles	48
		Wagons and carriages	95
		Woodenware	13½
Total	23,561½	Total	10,285½
Total approximate value	$1,120,380	Total approximate value	$966,386

II 10.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

The original condition of the mouth of the Kewaunee River, object of the improvement, projects, and piers built to June 30, 1896, were described in detail in Annual Report of Chief of Engineers for 1896, page 2486. Since then the north pier has been extended 200 feet and the south pier 225 feet.

Condition of the improvement.—The piers are now built the full length contemplated. About 500 linear feet of the shore ends of the piers built in 1882 requires renewal of the superstructure; in other respects they are in good condition. Soundings taken April 25, 1898, on the completion of dredging, showed a channel between the piers 15 feet deep below the datum plane of harbor improvements, with a width of 200 feet at entrance, and a minimum width of about 100 feet. It is probable that no material change in depth has occurred since that date. The actual depth June 30, 1898, was 14.5 feet.

Operations during the fiscal year.—Under contract dated December 11, 1896, with Thomas J. McGrath, for the construction of 425 linear feet, more or less, of pile pier for the extension of the north pier 200 feet and the south pier 225 feet, work was begun May 10, 1897, completed December 11, 1897, and the contract closed. The details of construction are the same as for the extension built in 1895, except that Wakefield triple-lap sheet piling, 2 by 12 inch pine planks, was used instead of the ordinary double sheet piling of 3 by 12 inch planks.

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List of materials and cost of same in place for building 425 linear feet of pile pier at Kewaunee Harbor, Wisconsin, under contract dated December 11, 1896, with Mr. Thomas J. McGrath, of Greenbay, Wis.

Materials.	Quantities.	Price.	Amount.
Round piles.....linear feet..	27,415	$0.16	$4,386.40
Wakefield triple-lap sheet piling.....feet B. M..	71,904	23.00	1,653.78
White-oak timber.....do....	29,704	38.06	1,128.73
White-pine timber.....do....	17,776	24.00	426.38
Pine deck plank.....do....	20,777	20.00	415.24
Stone.....cords..	1,579.6	4.75	7,503.10
Iron screw bolts and tie-rods.....pounds..	17,751	.025	443.78
Iron spikes.....do....	2,054	.04	82.16
Total.....	.....	.....	16,039.87

Cost per linear foot, $37.74.

By hire of labor, the use of U. S. dredge No. 2, and the purchase of materials in accordance with law, dredging was begun November 16, 1897, and closed for the season November 29, resumed March 29, 1898, and completed April 25, resulting in the removal of 25,701 cubic yards of material.

At the yard adjoining the Government warehouse a center dump scow of 135 cubic yards capacity, and launching ways to be used from time to time in conjunction with repairs to the dredging plant, were built. The former was built from appropriations for the improvement of Waukegan, Manitowoc, and Menominee harbor, and the latter from Kewaunee, Manitowoc, and Sheboygan harbor appropriations. Repairs were also made to the dredging plant, and minor repairs were made to the piers.

Remarks.—The channel is subject to constant deterioration by the deposit of sediment brought in by the river, waves from the lake, and other causes. It is impossible to estimate the exact quantity deposited each year, but it is believed that about 30,000 cubic yards will have to be removed during the fiscal year ending June 30, 1900. About 500 feet of the superstructure is now in a decayed condition and should be renewed at once. The superstructure is constantly subject to decay and requires renewal from time to time. The estimate for renewal of superstructure is $10 per linear foot.

By deed of gift dated November 9, 1897, the title to the land occupied by the harbor piers was conveyed to the United States for harbor purposes by Mr. Joseph Duvall and wife.

Estimate for fiscal year ending June 30, 1900.

Dredging 30,000 cubic yards, at 10 cents	$3,000
Repairs to piers	5,000
Contingencies, 10 per cent	800
Total	8,800

An appropriation of $8,800 for maintenance of existing works is recommended for fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$20,331.33
June 30, 1898, amount expended during fiscal year	20,109.66
July 1, 1898, balance unexpended	221.67
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	8,800.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

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Appropriations.

Act of—		Act of—	
March 3, 1881	$5,000	August 18, 1894	$20,000
August 2, 1882	12,000	June 3, 1896	25,000
July 5, 1884	18,000	Miscellaneous receipts credited to appropriations	14
August 5, 1886	10,000		
August 11, 1888	10,000	Total	150,014
September 19, 1890	20,000		
July 13, 1892	30,000		

Appropriated by local authorities in 1881 and expended by the United States under the direction of the engineer officer in charge, $8,042.72.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Kewaunee, Wis.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light house, on north pierhead, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	650	461,287	650	461,287
Sail	275	14,900	275	14,900
Total	925	476,187	925	476,187

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	30	Apples	225
Apples	15	Barley	47
Bark (tan)	660	Beans	3
Barley	799	Beer	420
Beans	9	Chairs	18
Beer	53	Cheese	1
Brick	2,800	Coal and coke	1,200
Butter	1,950	Corn	980
Cattle	1,770	Furniture	17
Cheese	1,000	Iron and steel	250
Corn	28	Lath	37
Eggs	300	Leather	19
Fish	45	Lime and cement	232
Flour	161,250	Lumber	600
Hay	20,000	Malt	6
Hides	25	Marble	25
Hogs	45	Merchandise (general)	8,500
Merchandise (general)	35,000	Mill stuffs	300
Mill stuffs	14,000	Oats	256
Oats	480	Oil	675
Peas	780	Plaster (land)	2,500
Pork and beef	120	Pork and beef	60
Poles (telegraph)	1,700	Potatoes	9
Posts (fence)	380	Provisions	70
Potatoes	2,700	Rye	336
Rye	1,058	Salt	1,650
Seeds	279	Sash, doors, and blinds	30
Sheep	160	Shingles	60
Stone	25,200	Stone	11,200
Wheat	1,770	Wheat	45
Wood	2,250	Wood	3,600
Wool	15	Woodenware	1
Total	276,671	Total	33,772
Total approximate value	$6,964,600	Total approximate value	$4,142,765

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I I II.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

The original condition of the mouth of Twin Rivers, object of the improvement, original project, and present works were described in detail in Annual Report Chief of Engineers for 1896, page 2489, and 1897, pages 2678 and 2679.

Condition of the improvement.—The dredging that was completed June 9, 1897, restored the channel to a depth of 13 feet for a width of 150 feet. Soundings taken May 12, 1898, showed that a bar, projecting from south to north, had formed at the harbor entrance with a minimum depth of water over it of 9.8 feet, and reducing the available width of channel between the pierheads to 75 feet; thence to the shore end of the piers the minimum width of channel, 13 feet deep, was 120 feet. The foregoing depths are below the datum plane of harbor improvements. It is probable that no material change in depth has occurred since that date. The actual depth June 30, 1898, was 12.5 feet.

The piers are built the full length contemplated. The crib piers are in good condition. The superstructure of the pile piers is in a dilapidated condition, being very much decayed. The sheet piling to the pile piers is very imperfect and does not prevent the passage of sand through the piers into the channel.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1898.

The original estimate for completing this work was	$265,588.80
There has been appropriated to date	214,500.00
Difference	51,088.80

The modification of the project, approved February 27, 1897, caused a reduction in the estimate of the foregoing difference.

For the fiscal year ending June 30, 1900, the following estimate is submitted for maintenance of channel and piers:

2,000 feet of superstructure and repairs to sheet piling, at $7	$14,000
Dredging 40,000 cubic yards, at 10 cents	4,000
Contingencies, 10 per cent	1,800
Total	19,800

Money statement.

July 1, 1897, balance unexpended	$262.51
June 30, 1898, amount expended during fiscal year	42.78
July 1, 1898, balance unexpended	219.73
Amount that can be profitably expended in fiscal year ending June, 30, 1900, for maintenance	19,800.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

Act of—		Act of—	
March 3, 1871	$25,000	August 2, 1882	$15,000
June 10, 1872	25,000	July 5, 1884	8,000
March 3, 1873	25,000	August 11, 1888	2,500
June 23, 1874	15,000	September 19, 1890	3,000
March 3, 1875	15,000	July 13, 1892	3,000
August 14, 1876	5,000	August 18, 1894	3,000
June 18, 1878	10,000	June 3, 1896	5,000
March 3, 1879	20,000		
June 14, 1880	20,000	Total	214,500
March 3, 1881	15,000		

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COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Two Rivers, Wis.]

Name of harbor, Two Rivers, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Two Rivers, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,589	251,332	1,589	251,332
Sail	55	4,381	55	4,381
Total	1,644	255,713	1,644	255,713

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	8	Agricultural implements	5
Butter	40	Apples	60
Cattle	9	Beer	87.5
Chairs	300	Chairs	2.5
Cheese	120	Cheese	2.5
Eggs	31	Fish	.5
Fish	82	Flour	322.5
Furniture and wood type	883	Leather	1.5
Hay	2,800	Lumber	1,500
Hides	10	Merchandise	50
Merchandise (general)	1,000	Oil	112.5
Oats	32	Plaster (land)	50
Oil	45	Pork and beef	36
Pease	1,260	Provisions	50
Potatoes	150	Salt	150
Veneers	500	Sash, doors, and blinds	100
Woodenware	3,645.5	Saw logs	45,000
Wool	2.5	Wood	3,750
Total	10,919	Total	51,280.5

BY ALL WAYS OF TRANSPORTATION.

EXPORTS.		IMPORTS.	
Barrel headings	460	Apples	22.5
Cattle	189	Coal and coke	6,000
Chairs	500	Corn	224
Hay	3,300	Flour	269
Lumber	7,500	Merchandise (general)	150
Merchandise (general)	1,232	Mill stuffs	100
Provisions	10		
Sheep	5		
Shingles	300		
Woodenware	5,869		
Total	19,305	Total	6,765.5

II 12.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

The original condition of the mouth of Manitowoc River, object of the improvement, projects, and piers built to June 30, 1896, were described in detail in Annual Report Chief of Engineers for 1896, page 2491, and 1897, pages 2681 and 2682. Since then the south pier has been extended 500 feet.

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Condition of the improvement.—The piers are in fair condition; minor repairs only are needed. The breakwater is in good condition. The channel was completed June 13, 1898, for a width of 160 feet, to the required depth of 20 feet below the datum plane of harbor improvements. No material change in depth has occurred since dredging was completed. The actual depth on June 30, 1898, was 19.5 feet.

Operations during the fiscal year.—Under contract dated December 11, 1896, with Hausler & Lutz Towing and Dock Company, of Chicago, Ill., for the extension of the south pier 500 feet by 5 cribs each 100 feet long, 24 feet wide, and 22½ feet high including the superstructure, 3 cribs were built and sunk in place, and continuous superstructure built over them, and 2 cribs that were sunk in June, 1897. The work was completed September 30, 1897, and the contract closed.

The materials used under this contract, and cost of same in place, are as follows:

Materials.	Quantities.	Price.	Amount.
Pine timber.....feet B. M..	367, 680	$19.50	$7, 169.76
Hemlock timber.....do....	334, 020	15.00	5, 010.30
Pine plank.....do....	31, 950	17.00	543.15
Driftbolts.....pounds..	53, 656	.02½	1, 341.40
Screw bolts.....do....	5, 849	.03	175.47
Spikes.....do....	1, 050	.05	52.50
Stone.....cords..	2, 031.3	5.00	10, 156.50
Piles.....number..	344	8.50	2, 924.00
Total.....	.....	.....	27, 373.06

Cost per linear foot, $54.75.

By hire of labor and purchase of materials in accordance with law, minor repairs were made to the piers, 500 linear feet of the south pier provided with new 3-inch pine decking, 500 linear feet of the north pier decking repaired, and the north pierhead provided with a line of fender piling for its protection. Repairs were also made to the dredging plant.

For the formation of a channel 20 feet deep, in accordance with the existing project, 58,669 cubic yards of material was excavated by U. S. dredge *No. 1.* This work was begun October 18, 1897, suspended for the season November 29, resumed March 29, 1898, and completed June 13, 1898.

Remarks.—The work performed during the past fiscal year completes the project outlined in House Doc. No. 300, Fifty-fourth Congress, first session, for providing a depth of 20 feet.

The city of Manitowoc has contracted for the dredging of 200,000 cubic yards of material for the purpose of extending the channel 20 feet in depth from the inner end of the harbor piers up the river for a distance of 1¼ miles. This work is now in progress and when completed will afford ample dockage facilities for the transaction of ordinary buisness, and also will be of great benefit to the large quantity of shipping that seeks shelter here during heavy gales.

Estimate for fiscal year ending June 30, 1900.

For dredging 20,000 cubic yards for maintenance of channel, at 10 cents.....	$2, 000
For minor repairs to piers.....	1, 000
For contingencies, 10 per cent.....	300
Total.....	3, 300

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An appropriation of $3,300 for maintenance of channel and repairs of piers for the fiscal year ending June 30, 1900, is recommended.

Money statement.

July 1, 1897, balance unexpended	$45,098.57
June 30, 1898, amount expended during fiscal year	39,111.85
July 1, 1898, balance unexpended	5,986.72
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	3,300.00

Appropriations.

Act of—		Act of—	
August 30, 1852	$8,000.00	March 3, 1881	$4,000.00
June 23, 1866	52,000.00	August 2, 1882	10,000.00
March 2, 1867	45,000.00	July 5, 1884	15,000.00
July 25, 1868 (allotted)	17,500.00	August 5, 1886	15,000.00
April 10, 1869 (allotted)	17,820.00	August 11, 1888	8,000.00
July 11, 1870	20,000.00	September 19, 1890	8,000.00
March 3, 1871	11,000.00	July 13, 1892	28,000.00
March 3, 1873	20,000.00	August 18, 1894	20,000.00
June 23, 1874	10,000.00	June 3, 1896	44,440.00
March 3, 1875	10,000.00	Miscellaneous receipts credited to appropriations	220.50
August 14, 1876	8,000.00		
June 18, 1878	15,000.00		
March 3, 1879	6,500.00		
June 14, 1880	7,000.00	Total	400,480.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. Thomas E. Torrison, mayor.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,341	2,017,305	1,310	1,985,333
Sail	336	104,310	333	98,466
Total	1,677	2,121,615	1,643	2,083,799

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		EXPORTS—continued.	
Agricultural implements	950	Coal and coke	12,300
Apples	127	Corn	11,200
Barley	28,200	Eggs	231
Beans	42	Flour	132,235
Beer	105	Furniture	61
Brick	1,000	Grain	11,000
Butter	237	Hay	11,000
Cattle	111	Hides	1,393
Cheese	818	Hogs	30

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Principal articles of export and import—Continued.

BY WAY OF THE HARBOR ONLY—Continued.

Articles.	Tons.	Articles.	Tons.
EXPORTS—continued.		IMPORTS.	
Iron and steel	8,891	Agricultural implements	485
Leather	3,700	Apples	1,575
Lumber	18,000	Bark (tan)	990
Malt	3,800	Beans	6
Merchandise (general)	17,370	Chairs	6
Mill stuffs	2,840	Coal and coke	250,000
Oats	64,000	Furniture	11
Oil	380	Hides	4,000
Peas	21,000	Iron and steel	42,047
Plaster (land)	218	Lath	2,200
Potatoes	8,000	Leather	6,372
Provisions	20	Lumber	5,000
Rye	28,000	Merchandise (general)	28,000
Salt	2,550	Pork and beef	36
Wagons and carriages	200	Provisions	13
Wheat	15,000	Salt	4,500
Woodenware	168	Shingles	750
Wool	23	Stone	5,600
		Wood	18,750
Total	401,781	Total	370,341
Total approximate value	$2,500,000	Total approximate value	$3,000,000

BY ALL WAYS OF TRANSPORTATION.

EXPORTS.		IMPORTS.	
Agricultural implements	4,000	Agricultural implements	1,515
Apples	172	Apples	240
Barley	30,500	Bark (tan)	1,870
Beans	48	Barley	25,250
Beer	3,500	Beans	27
Brick	4,000	Beer	53
Butter	350	Brick	325
Cattle	900	Butter	81
Cheese	1,250	Cattle	10
Coal and coke	230,000	Chairs	9
Corn	19,600	Coal and coke	270,000
Eggs	350	Corn	8,400
Fish	145	Eggs	17
Furniture	147	Flour	139,750
Flour	136,555	Hay	3,000
Grain	12,500	Furniture	532
Hay	27,000	Hides	5,444
Hides	1,928	Iron and steel	5,439
Hogs	1,000	Lath	2,714
Iron and steel	8,928	Leather	1,000
Leather	4,251	Lime and cement	489
Lumber	67,188	Lumber	6,180
Malt	17,100	Malt	139
Merchandise (general)	21,445	Marble	25
Mill stuffs	7,000	Merchandise (general)	67,020
Oats	8,000	Mill stuffs	471,890
Oil	456	Oats	64,000
Peas	27,000	Oil	500
Plaster (land)	719	Peas	60,000
Potatoes	4,110	Plaster (land)	1,000
Provisions	39	Pork and beef	103
Rye	31,178	Potatoes	15,000
Salt	5,512	Provisions	67
Wagons and carriages	763	Rye	25,200
Wheat	18,000	Salt	6,000
Woodenware	219	Sash, doors, and blinds	90
Wool	25	Shingles	1,050
		Stone	9,100
Total	690,978	Wagons and carriages	950
		Wheat	15,000
Total approximate value	$6,600,000	Wood	22,500
		Woodenware	30
		Total	1,242,009
		Total approximate value	$5,100,000

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II 13.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

The original condition of the mouth of Sheboygan River, object of the improvement, projects, and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, page 2495, and 1897, page 2685.

Condition of the improvement.—The south pier is in good condition. The shore end of the north pier is of very inferior construction, and to place it in good order about 1,000 linear feet should be revetted with triple-lap sheet piling. Each pier requires an extension of about 100 feet to complete the project of 1881. On June 30, 1898, the channel was 19 feet deep below the datum plane of harbor improvements for a width of 80 feet. The actual depth on that date was 18.5 feet.

Operations during the fiscal year.—By hire of labor and the use of U. S. dredge No. 1, 46,699 cubic yards of sand, clay, etc., was removed from the channel. Also 3,000 cubic yards of stone filling was dredged from the old pier and used as filling for the new pier and for riprap. While removing the old pier with the dredge several wrecks were found. The removal of some of them proved to be quite difficult, on account of their being buried so deeply in the sand. The dredging was in progress June 30, 1897; it was suspended October 13, resumed June 15, 1898, and will probably be completed in August, 1898. A section of pile pier 328 feet long, to connect the pier built in 1895 on the rectified line with the crib pier, was in process of construction June 30, 1897, about 100 linear feet having been completed on that date. The remainder (228 feet) was completed, 200 linear feet of superstructure of the north pier rebuilt six courses in height, and repairs made to the decking of both piers. Repairs were also made to the dredging plant.

Remarks.—For the completion of the existing project and maintenance of channel and piers it is recommended that $30,000 be appropriated for the fiscal year ending June 30, 1900.

The estimate for fiscal year ending June 30, 1900, is as follows:

To complete the existing project	$26,600
For maintenance of channel and piers	3,400
Total	30,000

Money statement.

July 1, 1897, balance unexpended	$12,399.48
June 30, 1898, amount expended during fiscal year	9,153.51
July 1, 1898, balance unexpended	3,245.97

Amount (estimated) required for completion of existing project	26,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, including $3,400 for maintenance	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

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Appropriations.

Act of—		Act of—	
August 30, 1852	$10,000.00	March 3, 1879	$3,000.00
June 28, 1864 (allotted)	10,000.00	June 14, 1880	7,000.00
June 23, 1866	47,598.91	March 3, 1881	25,000.00
March 2, 1867	8,000.00	August 2, 1882	30,000.00
April 10, 1869 (allotted)	14,850.00	July 5, 1884	28,000.00
July 11, 1870	15,000.00	August 5, 1886	15,000.00
March 3, 1871	15,000.00	August 11, 1888	15,000.00
June 10, 1872	18,000.00	September 19, 1890	15,000.00
March 3, 1873	10,000.00	July 13, 1892	25,000.00
June 23, 1874	10,000.00	August 18, 1894	25,000.00
March 3, 1875	12,000.00	June 3, 1896	26,000.00
August 14, 1876	6,000.00		
June 18, 1878	4,000.00	Total	394,448.91

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. E. P. Ewer.]

Name of harbor, Sheboygan, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam and sail	1,093	580,980	1,090	578,182

Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Agricultural implements	350	Chairs	7,500
Apples	90	Coal and coke	290,000
Beer	1,050	Corn	1,260
Chairs	15,000	Flour	645
Cheese	4,957	Furniture	2,250
Coal and coke	200,000	Glass	1,000
Eggs	148	Hay	350
Furniture	18,000	Hides	5,450
Iron and steel	3,100	Iron and steel	3,800
Leather	2,450	Laths	715
Lime and cement	1,709	Leather	200
Malt	6,750	Lime and cement	275
Merchandise (general)	1,800	Lumber	72,000
Mineral water	850	Malt	262.5
Pease	930	Marble	300
Potatoes	258	Merchandise (general)	15,000
Salt	10,500	Mill stuffs	600
Stone	2,400	Oats	1,120
Toys	485	Oil	2,407
Veneering	3,000	Poles (telegraph)	685
Woodenware	3,632	Posts (fence)	646
		Sand	500
Total	277,519	Salt	11,400
IMPORTS.		Sash, doors, and blinds	4,000
Agricultural implements	500	Shingles	1,500
Apples	150	Stone	292.5
Bark (tan)	15,840	Ties (railroad)	700
Barley	4,582.5	Wood	35,000
		Total	509,230.5

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II 14.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

The original condition of the mouth of Sauk River, object of the improvement, projects, and present works, was described in detail in Annual Report, Chief of Engineers, for 1896, page 2499.

Condition of the improvement.—The piers were completed in 1893. The channel and basins had, with minor exceptions, the required depth of 13 feet at the close of dredging in 1895, and the object of the improvement was then practically obtained. The piers are in good condition, with the exception of about 100 linear feet of superstructure, that requires renewal. Soundings taken in May, 1898, showed that considerable shoaling had occurred in the entrance channel and in the westerly half of the west basin. The governing depth in the entrance channel May 2 was 12 feet below the datum plane of harbor improvements. From May to June 30, 1898, it is probable that no material change in depth had occurred. The actual depth June 30, 1898, was 11.5 feet.

Operations during the fiscal year.—By hire of labor and purchase of materials in accordance with law the rebuilding of decayed superstructure of the north and south piers was begun May 17, 1897, and completed July 28. During this period 370 feet of the north pier and 320 feet of the south pier, a total of 690 feet, were rebuilt; 370 feet of the same was completed during the fiscal year. Minor repairs were also made to the decking of the piers.

List of materials used and cost of same for rebuilding 690 linear feet of crib superstructure 14 feet wide and 5 feet high at Port Washington Harbor, Wisconsin.

112,800 feet B. M. white-pine timber, at $14.50	$1,635.60
7,200 feet B. M. white-pine plank, at $14.50	104.40
10,640 pounds iron driftbolts, at $1.62½ per 100 pounds	172.90
300 pounds iron spikes, at 2 cents	6.00
Tools	34.00
Rent of scow 71 days, at $1	71.00
Cartage on materials	3.00
Labor, including pay of overseer	957.30
Total	2,984.20

Cost per linear foot, $4.32½.

Remarks.—It is proposed to transfer, in July or August, the United States dredge now at Sheboygan, and do such dredging at this harbor as is urgently needed the present season with funds now available.

Estimate for fiscal year ending June 30, 1900.

For dredging for restoration and maintenance of channel	$3,500.00
For minor repairs to pier	500.00
Contingencies	400.00
Total	4,400.00

An appropriation of $4,400 for maintenance of channel and repairs of piers for the fiscal year ending June 30, 1900, is recommended.

Money statement.

July 1, 1897, balance unexpended	$3,158.92
June 30, 1898, amount expended during fiscal year	1,533.97
July 1, 1898, balance unexpended	1,624.95
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	4,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

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Appropriations.

Act of—		Act of—	
July 11, 1870	$15,000.00	July 5, 1884	$10,000.00
March 3, 1871	15,000.00	August 5, 1886	5,000.00
June 10, 1872	15,000.00	September 11, 1888	5,000.00
March 3, 1873	15,000.00	September 19, 1890	3,000.00
June 23, 1874	10,000.00	July 13, 1892	6,500.00
March 3, 1875	10,000.00	August 18, 1894	5,000.00
August 14, 1876	8,000.00	June 3, 1896	5,500.00
June 18, 1878	5,000.00	Miscellaneous receipts credited to appropriations	36.50
March 3, 1879	7,500.00		
June 14, 1880	20,000.00		
March 3, 1881	17,000.00		
August 2, 1882	17,000.00	Total	194,536.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Port Washington, Wis.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on outer end of north pier, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	967	75,600	963	75,400
Sail	121	11,700	121	11,700
Total	1,088	87,300	1,084	87,100

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	4	Agricultural implements	85
Barley	5,170	Bark (tan)	1,650
Beans	27	Beer	70
Beer	52	Chairs	8
Brick	4,200	Coal and coke	4,000
Butter	43	Corn	70
Chairs	4,175	Flour	269
Cheese	32	Furniture	16
Eggs	16	Hides	620
Fish	337	Iron and steel	2,900
Flour	1,886	Lath	275
Furniture	2,025	Lime and cement	73
Hay	900	Lumber	13,350
Hides	13	Malt	40
Hogs	15	Marble	60
Iron and steel	2,900	Merchandise (general)	1,950
Leather	318	Oil	1,013
Lime and cement	1,160	Pork and beef	12
Mill stuffs	400	Posts (fence)	48
Oats	512	Salt	36
Peas	210	Saw logs	6,000
Potatoes	480	Shingles	150
Provisions	5	Wheat	240
Woodenware	2,400	Wood	11,250
Wool	2		
Total	27,282	Total	54,185
Total approximate value	$1,260,000	Total approximate value	$1,132,000

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II 15.

IMPROVEMENT OF HARBOR OF REFUGE AT MILWAUKEE, WISCONSIN.

The original condition of Milwaukee Bay, object of the improvement, projects, breakwater built to June 30, 1896, were described in detail in Annual Report, Chief of Engineers for 1896, page 2502. Since then the main arm of the breakwater has been extended 1,500 feet by cribs 30 feet wide, making the total length of main arm at the present time 3,700 feet, of which 2,000 feet is unprovided with superstructure.

Condition of the improvement.—Soundings taken in December, 1897, showed a depth of water along main arm varying from 25 feet at the angle to 35 feet at southerly end. Area covered by present works, outside 13-foot contour, 334 acres; outside 19-foot contour, 203 acres; omitting the 2,000 feet of pier without superstructure, the area covered by completed works, outside 13-foot contour, is 165 acres; outside the 19-foot contour is 101 acres.

Operations during the fiscal year.—Under contract dated January 13, 1897, with Knapp & Gillen, of Racine, Wis., for the extension of the breakwater 1,600 feet, more or less, work has been in progress during the fiscal year. The extension consists of timber cribs, each 100 feet long by 30 feet wide, and 25½ feet high, without superstructure, placed on a stone foundation. During the fiscal year 5,557.4 cords of stone have been placed in the foundation and 15 cribs completed and sunk in place.

By hire of labor and purchase of materials, in accordance with law, minor repairs have been made to the breakwater.

The schooner *Surprise* has been engaged to serve as a light-ship at the south end of the breakwater upon the same terms and from the same individuals as the scow *Dunham* in previous years.

Remarks.—The contract now in force has been extended to August 3, 1898, by which time the work embraced thereunder will probably be completed and the contract closed.

At the beginning of the fiscal year there remained of the original project yet to be built 2,600 feet of breakwater and 500 feet of superstructure to be placed on work already built. The accepted bid for the construction of work authorized by the river and harbor act of June 3, 1896, was so low that it has been found possible to build 1,700 feet of breakwater without superstructure.

After the completion of the present contract there will remain funds on hand sufficient to build 300 linear feet of superstructure, but owing to the failure of the river and harbor bill it has been considered advisable to defer its construction until a further appropriation shall have been made, reserving the funds now on hand for contingent expenses and unforeseen repairs.

There remains, therefore, of the original project 900 feet of breakwater and 1,900 feet of superstructure, for which appropriations have yet to be made. The exact cost can not be foretold, and it is not safe to use the present contract price in estimating it, because this price is unusually low. It is believed that $115 per foot is a safe estimate.

Estimate of cost of completing breakwater at harbor of refuge, Milwaukee, Wis.

900 feet of crib work on stone foundation, complete, at $115 per foot	$103,500
1,900 feet of superstructure, at $20	38,000
Contingencies, 10 per cent	14,150
Total	155,650

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In the annual report upon this improvement for 1896 it was explained in detail why its final cost has exceeded the original estimate. The principal items, not included in the original estimate and paid for from appropriations for the work, are (1) maintenance of light-ship for fourteen years (1884 to 1897, inclusive), $20,339.94, and (2) repairs to breakwater, $77,163.20, after damage by severe storms.

An appropriation of $155,650 is recommended for the fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$173,685.56
June 30, 1898, amount expended during fiscal year	133,749.12
July 1, 1898, balance unexpended	39,936.44
July 1, 1898, amount covered by uncompleted contracts	34,616.09
July 1, 1898, balance available	5,320.35
Amount (estimated) required for completion of existing project	155,650.00
Amount that can be profitably expended in fiscal year ending June 30, 1900	155,650.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—		
March 3, 1881		$100,000.00
August 2, 1882		100,000.00
July 5, 1884		85,000.00
August 5, 1886	$60,000.00	
From which allotted to Milwaukee Harbor	4,737.91	
		55,262.09
August 11, 1888		70,000.00
September 19, 1890		80,000.00
July 13, 1892		75,000.00
August 18, 1894		45,000.00
June 3, 1896		20,000.00
June 4, 1897		168,737.91
Miscellaneous receipts credited to appropriations		1,000.00
		800,000.00

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Knapp & Gillen	1,700 feet breakwater.	Jan. 27, 1897	Apr. 24, 1897	Aug. 8, 1898

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

Name of harbor, Harbor of Refuge, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected at nearest port of entry, $290,860.30. (See the commercial statistics for Milwaukee Harbor, Wisconsin.)

I I 16.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

The original condition at the mouth of the Milwaukee River, the object of the improvement, projects, and present works were described in detail on page 2506, Part IV, Annual Report of the Chief of Engineers for 1896.

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Condition of the improvement.—The harbor piers were completed to their projected length in 1872. Soundings taken in May, 1898, showed a channel midway between the piers with a least width of 90 feet and 19 feet deep below the datum plane of harbor improvements. It is probable that no material change in depth has occurred since soundings were taken. The actual depth on June 30, 1898, was 18.5 feet.

Operations during the fiscal year.—There have been no operations during this fiscal year.

Tridaily observations of water levels of Lake Michigan were made and recorded.

Remarks.—Since the last report the condition of the harbor piers has been steadily growing worse. The older portion of the superstructure of the south pier (about 600 feet in length) is now in such an advanced state of decay that it is impossible to walk over it, and a southeasterly gale is liable at any time to make a breach in the pier. The repairs to the harbor piers are of the most urgent and pressing importance.

Estimate for fiscal year ending June 30, 1900.

Rebuilding 600 feet superstructure (south pier), at $5.59	$3,354
Reconstructing 1,100 linear feet protection piling (south pier), at $3.50	3,850
Repairs to north pier stone superstructure	1,600
Dredging for maintenance of channel	4,000
Contingencies	1,196
Total	14,000

An appropriation of $14,000 for maintenance of existing works is urgently recommended for fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$1,816.87
June 30, 1898, amount expended during fiscal year	632.79
July 1, 1898, balance unexpended	1,184.08
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	14,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Expended on former mouth of Milwaukee River.

Act of—	
July 4, 1836	$400.00
March 3, 1843	30,000.00
June 11, 1844	20,000.00

Straight cut.

Act of—	
August 30, 1852	15,000.00
March 3, 1853	163.94
June 23, 1866	48,283.51
April 10, 1869 (allotted)	35,640.00
July 11, 1870	40,000.00
March 3, 1871	38,000.00
March 3, 1873	10,000.00
March 23, 1874	10,000.00
March 3, 1875	25,000.00
August 14, 1876	26,000.00

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Act of—	
June 18, 1878	$15,000.00
March 3, 1879	7,500.00
June 14, 1880	10,000.00
March 3, 1881	8,000.00
August 2, 1882	10,000.00
August 5, 1886 (from appropriation for harbor of refuge)	4,737.91
August 11, 1888	10,000.00
March 17, 1890 (special act)	6,100.00
September 19, 1890	6,000.00
July 13, 1892	14,000.00
August 18, 1894	7,000.00
June 3, 1896	7,000.00
Total expended at old river mouth and straight cut	403,825.36
Expended at former mouth of Milwaukee River	50,400.00
Total expended at straight cut (present harbor)	353,425.36

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. W. J. Langson, secretary chamber of commerce.]

Name of harbor, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected during the year, $290,860.30.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	4,610	4,340,363	4,682	4,432,308
Sail	1,373	317,176	1,368	296,797
Total	5,983	4,657,539	6,050	4,729,105

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		EXPORTS—continued.	
Barley	131,216	Wheat	38,199
Beans	323	Wool	1,276
Beer	305	Total	1,093,457
Brick	20		
Butter	60	IMPORTS.	
Cement	11,618		
Cheese	586	Bark (tan)	492,247
Coal	120	Barley	197
Corn	48,650	Beans	2,341
Eggs	46	Brick	740
Flour	373,614	Butter	38
Hay	539	Cement	7,831
Hides	120	Cheese	42
Iron	19,160	Coal	1,493,528
Laths	82	Corn	586
Leather	5,438	Eggs	137
Lime	111	Flour	406
Lumber	74,991	Hay	230
Malt	55,693	Hides	4,065
Mill stuffs	142,087	Iron	17,477
Oats	127,382	Iron ore	77,323
Pease	9,487	Laths	1,849
Pork and beef	1,114	Leather	103
Potatoes	438	Lumber	176,973
Rye	50,189	Mill stuffs	58
Salt	578	Oil	277
Shingles	15		

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Principal articles of export and import—Continued.

BY WAY OF THE HARBOR ONLY—Continued.

Articles.	Tons.	Articles.	Tons.
IMPORTS—continued.		IMPORTS—continued.	
Pease	10,715	Ties (railroad)	1,318
Posts (fence)	3,560	Wheat	10,310
Potatoes	1,522	Wood	168,382
Rye	714	Woodenware	20
Salt	86,198	Wool	185
Shingles	1,509		
Stone	95,574	Total	2,656,389

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Butter	277	Bark (tan)	59,072
Barley	147,379	Barley	258,232
Beans	670	Beans	2,660
Beer	265,400	Brick	14,880
Brick	1,160	Butter	2,564
Cattle	4,079	Cattle	15,363
Cement	81,195	Cement	13,420
Chair stock	920	Chair stock	1,460
Cheese	1,024	Cheese	2,619
Coal	652,867	Coal	1,555,808
Corn	52,544	Corn	106,505
Eggs	130	Eggs	3,470
Flour	421,916	Flour	263,208
Hay	1,303	Hay	18,076
Hides	998	Hides	25,073
Hogs	1,636	Hogs	99,882
Iron	228,549	Iron	108,324
Latha	60	Iron ore	95,857
Leather	10,618	Laths	2,427
Lime	111	Leather	1,643
Lumber	18,779	Lime	15,316
Malt	76,852	Lumber	284,065
Mill stuffs	153,136	Malt	32,618
Oats	142,149	Mill stuffs	45,263
Pease	9,612	Oats	168,378
Pork and beef	9,318	Oil	49,768
Potatoes	3,028	Pease	11,435
Rye	52,558	Posts (fence)	3,535
Salt	88,058	Potatoes	9,295
Sheep	606	Rye	48,241
Shingles	465	Salt	86,843
Wheat	60,900	Sheep	1,907
Woodenware	1,760	Shingles	1,719
Wool	1,520	Stone	170,857
		Ties (railroad)	4,275
Total	2,491,568	Wheat	258,804
		Wood	210,702
		Woodenware	4,840
		Wool	6,440
		Total	4,065,544

I I 17.

IMPROVEMENT OF SOUTH MILWAUKEE HARBOR, WISCONSIN.

The original condition of the mouth of Oak Creek, object of the improvement, project, and piers built to June 30, 1896, were described in detail in Annual Report, Chief of Engineers for 1896, pages 2509, 2510. Since then the north pier has been extended 185 feet, making its total length at the present time 785 feet.

Condition of the improvement.—There has been no material change in the condition of the improvement from that published in Annual Report Chief of Engineers for 1897, page 2696, except an extension of 185 feet to the north pier.

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Operations during the fiscal year.—Under contract dated December 9, 1896, with Mr. P. W. Galloway, of Racine, Wis., for the construction of 180 linear feet, more or less, of pile pier in extension of the north pier, work was to have begun May 1, 1897. Owing, however, to the contractor being engaged in making urgently needed repairs to the harbor piers at Kenosha and Racine, the work was not commenced until August 14; it was completed November 10, 1897, and the contract closed.

The work done under this contract consists of 185 linear feet of pile pier, 14 feet wide, provided on the outer or lake side with Wakefield triple-lap sheet piling of 2-inch Norway pine planks, planed to an even thickness.

List of materials and cost of same in place for building 185 linear feet of pile pier in extension of the north pier at South Milwaukee, Wis., under contract dated December 9, 1896, with Mr. P. W. Galloway, of Racine, Wis.

Materials.	Quantities.	Price.	Amount.
Round piles ..... linear feet..	6,173	$0.20	$1,234.60
Wakefield triple-lap sheet piling ..... feet B. M..	26,352	27.00	711.50
White-oak timber ..... do....	12,044	36.00	433.58
White-pine timber ..... do....	6,240	20.00	124.80
White-pine decking plank ..... do....	2,256	18.00	40.61
Stone ..... cords..	297.3	5.50	1,635.15
Iron screw bolts and tie-rods ..... pounds..	5,580	.03	167.40
Iron spikes ..... do....	511	.04	20.44
Total	.....	.....	4,368.08

Cost per linear foot, $23.61.

Remarks.—In its present condition the harbor of South Milwaukee is of no benefit to general commerce. That any material and lasting benefit may be derived it is necessary that both piers be extended to the length called for by the present project and a channel dredged between them.

The estimated cost of completion of present project (see Report of Chief of Engineers, 1895, p. 2643) is $133,000.

Money statement.

July 1, 1897, balance unexpended	$4,964.11
June 30, 1898, amount expended during fiscal year	4,685.30
July 1, 1898, balance unexpended	278.81
Amount (estimated) required for completion of existing project ..... Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	133,000.00

Appropriation.

Act of June 3, 1896	$5,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. Fred. W. Rogers, secretary South Milwaukee Company.]

Name of harbor, South Milwaukee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, north pier, Milwaukee, Wis.

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Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.—continued.	
Cattle	240	Furniture	38
High wines	1,200	Hay	800
Iron and steel	13,500	Iron and steel	16,050
Malted meat	13	Lime and cement	850
Mineral wool	1,200	Lumber	2,504
Total	16,153	Malt	150
Total approximate value	$1,105,000	Merchandise (general)	27,500
IMPORTS.		Mill stuffs	120
Agricultural implements	29	Oats	771
Apples	225	Oil	7,712
Barley	940	Pork and beef	552
Beans	30	Poles (telegraph)	510
Beer	1,022	Posts (fence)	95
Brick	3,400	Rye	268
Butter	79	Salt	200
Cattle	240	Sash, doors, and blinds	13
Cheese	17	Shingles	90
Coal and coke	16,000	Ties (railroad)	21,000
Corn	5,460	Wood	3,750
Flour	322	Total	110,837
		Total approximate value	$1,138,878

I I 18.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

The original condition of the mouth of Root River, object of the improvement, projects, and piers built to June 30, 1896, were described in detail in Annual Report of Chief of Engineers for 1896, pages 2511 and 2512. Since then the south pier has been extended 250 feet by cribs 20 feet wide, making total length of south pier at present time 1,720 feet.

A modification of project approved March 9, 1897, provides for the construction of 900 linear feet of sheet piling and dredging for maintenance of channel.

Condition of the improvement.—Both piers are now of the full length contemplated under the revised project of 1889.

Soundings taken in April, 1898, showed a channel 15 feet deep below the datum plane of harbor improvements having a width at entrance of about 225 feet and a least width of about 60 feet. It is probable that no material change in depth has occurred since soundings were taken. The actual depth June 30, 1898, was 14.5 feet.

Operations during the fiscal year.—Under an agreement dated April 17, 1897, with Mr. P. W. Galloway, of Racine, Wis., to furnish all machinery, tools, and labor necessary to extend the line of sheet piling on the channel face of the north pier, work was begun July 8 and completed July 31, 1897. Two hundred and eighty-four linear feet of revetment was built, being an extension easterly of the revetment completed in 1896, and making the total length of revetment 565 feet.

An agreement was entered into November 10, 1897, with the Racine Dredge Company to do such dredging as available funds would permit, for the removal of a shoal in the channel extending from abreast of the light-house crib to the shore end of the piers, a distance of about 800 feet, and which formed a serious obstruction to navigation, several vessels having grounded thereon. Under this agreement 5,998 cubic

yards of material was excavated, and resulted in increasing the governing depth in the channel from 14½ feet to 16½ feet. The work was begun November 19 and completed November 27, 1897.

By hire of labor and purchase of materials in accordance with law, minor repairs were made to the piers, and a cluster of piles was driven to afford protection to the south pierhead.

Remarks.—Extensive shoaling has taken place between the piers during the past fiscal year, and although the channel was restored to a depth of 16½ feet late in November, 1897, the controlling depth is now but 15 feet. The present condition of the piers is such as to render futile all attempts at maintaining a channel of the projected depth of 17 feet.

The inshore portions of the piers are in a dilapidated condition; originally of inferior construction, they have now so far fallen into decay as to offer but little obstruction to the passage of sand through them. The sheet piling built, 1896–97, along part of the north pier, has remedied the trouble to a considerable extent over the part so protected. About 900 linear feet of the south pier should be protected in a similar manner, and 300 linear feet of the north pier superstructure should be rebuilt at once.

While the inshore portion of the north pier superstructure is in a very dilapidated condition, it is not considered advisable to rebuild it, for should the project of improvement be enlarged in accordance with report of survey published in Annual Report Chief of Engineers for 1897, pages 2768–2772, so as to provide a channel 21 feet deep, the plan of improvement therein recommended provides for the entire removal of the inshore portion of the north pier, and the widening of the channel at that point. It is understood that the city of Racine has taken measures to condemn the land necessary for such widening and transfer it to the United States.

During the past fiscal year a series of observations have been taken for the purpose of obtaining reliable and accurate information as to direction and velocity of currents in Lake Michigan, and, if possible, to determine the cause of such currents and what effect they may have in the formation of bars at the various harbor entrances. Racine Harbor was selected as offering the best opportunities for conducting these observations, which were carried on during the summer and fall by Mr. Walter K. Means, assistant engineer.

A complete hydrographic survey was made of the harbor and vicinity, extending about three-quarters of a mile north and south from the harbor entrance, and from a half to one mile out from the shore. Over this area soundings were taken at intervals of about one hundred feet. The map transmitted herewith shows the contours for each foot in depth over the greater portion of the area covered by the survey, and is believed to be an accurate representation of the present lake bottom.

Observations of barometer, thermometer, direction and force of wind, and water gauge were made tri-daily during the months of September, October, and November, and frequent observations were made of the direction and velocity of the currents in the lake. These last observations could not be taken with any great regularity, being dependent upon weather conditions. A Price current meter, with electric register, was used in determining velocity of currents.

While these observations show the existence of currents in Lake Michigan, they fail to connect the observed currents with variations of either temperature, barometric pressure, or water level, or to exhibit a general current to either north or south. It is believed, however, that the results obtained are valuable, and that further observations,

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conducted over a greater period of time, may develop a series of results that will render possible a solution of the problem of the permanent improvement of lake harbors. During the present season, similar observations will be conducted at Sturgeon Bay Canal by Mr. Adam N. Dier, superintendent of the canal.

Estimate for fiscal year ending June 30, 1900.

900 linear feet sheet piling, at $15	$13,500
Dredging for maintenance of channel	8,000
Rebuilding superstructure, 300 feet by 30 feet, north pier	2,400
Contingencies	2,400
Total	26,300

An appropriation of $26,300 for completion of existing project and maintenance of existing works for the fiscal year ending June 30, 1900, is recommended.

Money statement.

July 1, 1897, balance unexpended	$14,970.99
June 30, 1898, amount expended during fiscal year	14,749.88
July 1, 1898, balance unexpended	221.11
Amount (estimated) required for completion of existing project	13,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, including $12,800 for maintenance	26,300.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—		Act of—	
June 15, 1844	$12,500	March 3, 1879	$6,000
August 30, 1852	10,000	June 14, 1880	6,000
June 28, 1864	3,600	March 3, 1881	6,000
June 23, 1866	23,910	August 2, 1882	7,000
March 2, 1867	45,000	July 5, 1884	7,000
April 10, 1869 (allotted)	22,275	August 5, 1886	10,000
July 11, 1870	10,000	August 11, 1888	10,000
March 3, 1871	10,000	September 19, 1890	17,500
March 3, 1873	20,000	July 13, 1892	25,000
June 23, 1874	10,000	August 18, 1894	20,000
March 3, 1875	10,000	June 3, 1896	27,000
August 14, 1876	8,000		
June 18, 1878	10,000	Total	336,785

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.

Arrivals and departures of vessels.

[Furnished by the collector of customs, Milwaukee, Wis.]

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,411	1,069,625	1,408	1,069,269
Sail	296	46,012	313	46,365
Total	1,707	1,115,637	1,721	1,115,634

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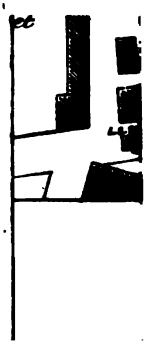

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Principal articles of export and import.

[Furnished by the mayor of Racine, Wis.]

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued..	
Agricultural implements	35,614	Corn	1,200
Apples	15	Eggs	225
Beer	6,051	Fish	158
Brick	23,644	Flour	8,213
Coal and coke	28,159	Furniture	604
Fish	31	Gamboge	848
Flour	540	Hay	7,411
Furniture	170	Hides	916
Hay	10,230	Hogs	1,657
Lath	811	Lath	976
Leather	630	Iron and steel	25,538
Lumber	17,700	Leather	392
Merchandise (general)	169,097	Lime and cement	3,158
Mill stuffs	16,918	Lumber	96,510
Oats	406	Marble	38
Oil	2,303	Merchandise (general)	242,423
Shingles	233	Mill stuffs	520
Stone	5,194	Oil	2,181
Wagons and carriages	13,962	Poles (telegraph)	26
Wool	121	Potatoes	388
		Posts (fence)	408
Total	331,839	Print paper	356
		Provisions	484
Total approximate value	$11,421,930.66	Rye	592
		Salt	1,185
IMPORTS.		Sash, doors, and blinds	72
		Sheep	332
Agricultural implements	533	Sheep skins	188
Apples	141	Shingles	390
Bark (tan)	2,112	Tobacco	64
Barley	3,610	Wheat	7,432
Beer	7,519	Wood	18,792
Brick	744	Woodenware	39
Butter	182	Wool	93
Cattle	2,056		
Chairs	217	Total	568,701
Cheese	100		
Coal and coke	183,178	Total approximate value	$6,631,786.89

I I 19.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

The original condition of the mouth of Pike Creek, object of the improvement, projects, and piers built to June 30, 1896, were described in detail in Annual Report, Chief of Engineers for 1896, page 2516. Since then the south pier has been extended 250 feet by cribs 20 feet wide, making total length of south pier at present time 1,366 feet.

Condition of the improvement.—Under the present project the north pier is to be extended 150 feet. The south pier is of the full length contemplated under the existing project. Soundings taken in April, 1898, showed a channel between the piers 16 feet deep below the datum plane of harbor improvements, with a width of entrance of about 130 feet and a least width of about 70 feet. There was a depth of 15 feet over an area of about 3½ acres in the basin. It is probable that no material change in depth has occurred since soundings were taken. The actual depth June 30, 1898, was 15.5 feet.

Operations during the fiscal year.—Under contract dated December 11, 1896, with McArthur Brothers Company, of Chicago, Ill., the south pier was extended 250 feet by two cribs, each 100 feet long, and one crib 50 feet long, the width of all the cribs being 20 feet and their height 20½ feet, including the superstructure. The work was begun June 3, 1897, completed September 23, 1897, and the contract closed.

Minor repairs were made to the piers during April, 1898.

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List of materials and cost of same in place for building 250 linear feet of south pier 20 feet wide and 20½ feet high, at Kenosha, Wis., under contract dated December 14, 1896, with MacArthur Brothers Company, of Chicago, Ill.

Materials.	Quantities.	Price.	Amount.
Pine timber.....feet B. M..	160,512	$20.00	$3,210.24
Hemlock timber.....do....	140,184	17.00	2,383.13
Pine plank.....do....	13,584	19.00	258.10
Drift bolts.....pounds..	24,734	.02½	618.35
Screw bolts.....do....	4,072	.02¾	111.98
Spikes.....do....	528	.03	15.84
Stone.....cords..	782.6	6.00	4,695.60
Piles.....number..	121	9.00	1,089.00
Total.....	.....	.....	12,382.24

Cost per linear foot, $49.53.

Remarks.—To complete the present project requires that the north pier should be extended 150 feet beyond its present length. The south pier is of its full projected length. Extensive repairs to the older portions of the piers are greatly needed. The west end of the north pier is in an extremely dilapidated condition, the extreme 60 feet of it having been carried away in 1885 and never having been restored. Erosion of the adjacent bank commenced at once and has continued ever since. Large quantities of material are thus washed into the channel by the action of every storm. The inner portions of both the harbor piers are in such condition as to readily permit of the passage of sand through them. It is believed that 1,500 feet of sheet piling will remedy this defect.

Should the project of improvement be enlarged in accordance with report of survey published in the Annual Report of the Chief of Engineers for 1897, pages 2772–2785, so as to provide for a channel 21 feet deep, further extension or repairs of the present north pier would be unnecessary, as the plan of improvement therein recommended provides for the entire removal of the pier.

Estimate for fiscal year ending June 30, 1900.

To extend the north pier to the full length contemplated by the modified project of 1889, 150 feet, at $65	$9,750
Making old piers sand tight, 1,500 linear feet of sheet piling, at $10	15,000
Protecting shore at inner end of north pier, 140 linear feet sheet piling, at $8.	1,120
Dredging for maintenance of channel	5,000
Contingencies	3,130
Total	34,000

An appropriation of $34,000 for completion of project and maintenance of existing works for the fiscal year ending June 30, 1900, is recommended.

Money statement.

July 1, 1897, balance unexpended	$18,290.51
June 30, 1898, amount expended during fiscal year	16,702.53
July 1, 1898, balance unexpended	1,587.98
Amount (estimated) required for completion of existing project	9,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, including $24,250 for maintenance	34,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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Appropriations.

Act of—		Act of—	
March 15, 1844	$12,500.00	June 14, 1880	$5,000.00
March 3, 1845	15,000.00	March 3, 1881	5,000.00
August 13, 1852	10,000.00	August 2, 1882	6,000.00
June 23, 1866	75,461.41	July 5, 1884	5,000.00
April 10, 1869 (allotted)	5,346.00	August 5, 1886	5,000.00
July 11, 1870	10,000.00	August 11, 1888	7,500.00
March 3, 1871	10,000.00	September 19, 1890	17,500.00
June 10, 1872	10,000.00	July 13, 1892	15,000.00
June 23, 1874	10,000.00	August 18, 1894	15,000.00
March 3, 1875	15,000.00	June 3, 1896	24,000.00
August 14, 1876	8,000.00		
June 18, 1878	8,000.00	Total	299,307.41
March 3, 1879	5,000.00		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by Mr. H. S. Van Ingen.]

Name of harbor, Kenosha, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.; nearest light-house, Kenosha, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage	Number.	Tonnage.
Steam	98	44,400	102	44,127
Sail	180		180	
Total	278	44,400	282	44,127

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Coal and coke	500	Iron and steel	750
Furniture	563	Lumber	15,000
Merchandise (general)	10,000	Laths	303
Provisions	3	Merchandise (general)	5,000
Sand and gravel	2,700	Oil	45
Total	13,766	Posts (fence)	124
		Potatoes	30
Total approximate value	$400,000	Shingles	750
		Stone	3,500
IMPORTS.		Wood	5,000
Apples	4	Total	70,206
Bark (tan)	25,850		
Coal and coke	13,000	Total approximate value	$1,500,000
Fish	850		

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Principal articles of export and import—Continued.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.
EXPORTS.	
Bicycles	407
Brass and copper	2,500
Butter	3
Coal and coke	1,000
Eggs	1
Fish	850
Furniture	12,987
Hay	800
Hides	1,220
Hosiery	1,000
Iron and steel	450
Leather	4,000
Malt	8,000
Merchandise (general)	25,000
Organ boards with reeds	70
Pork and beef	120
Provisions	500
Sand and gravel	6,750
Wagons and carriages	3,750
Woodenware	458
Total	69,896
Total approximate value	$15,000,000
IMPORTS.	
Agricultural implements	45
Apples	88
Bark (tan)	25,850
Barley	8,818
Beans	12
Beer	875
Brick	10,000
Butter	20
Cattle	75
Chairs	8
Charcoal	15
Cheese	10
Chemicals	8

Articles.	Tons.
IMPORTS—continued.	
Coal and coke	40,000
Copper, nickel, and silver	1,257
Corn	112
Eggs	11
Fish	850
Flour	1,200
Furniture	75
Hay	1,000
Hides	2,500
Hogs	400
Iron and steel	12,500
Lath	358
Leather	1
Lime and cement	2,175
Lumber	28,500
Marble	4
Merchandise (general)	70,000
Mill stuffs	4,500
Oats	96
Oil	4,050
Peas	9
Pork and beef	600
Poles (telegraph)	85
Posts (fence)	124
Potatoes	180
Provisions	250
Salt	300
Sash, doors, and blinds	18
Sheep	80
Shingles	750
Stone	10,500
Wagons and carriages	20
Wood	6,250
Woodenware	2
Wool and cotton	600
Zinc	375
Total	242,556
Total approximate value	$10,000,000

II 20.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

The original condition at Waukegan Harbor, object of the improvement, projects, and present works were described in detail in Annual Report Chief of Engineers for 1896, pages 2519 and 2520, and for 1897, page 2706.

Condition of the improvement.—Both piers are now of the full projected length. Under the project of 1896, 38 linear feet of revetment have been built to connect the north and south arm of north pier with the Elgin, Joliet and Eastern Railway Company's revetment, formerly the property of the American Mortar Company, and the shore line in the harbor has been riprapped with heavy blocks of stone for a distance of about 360 feet, beginning 40 feet from the south pier.

Soundings taken April, 1898, showed a channel between the piers 13 feet deep and with a least width of about 200 feet, and the same depth in the harbor or basin over nearly its entire area. With the exception of dredging now being done by the city of Waukegan, it is probable no material change in depth has occurred since soundings were taken. The actual depth June 30, 1898, was 12.5 feet.

Operations during the fiscal year.—Under contract dated September 23, 1896, with Illinois Dredging Company for dredging 122,000 cubic yards, more or less, from the entrance channel and basin, work was in

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progress at the beginning of the fiscal year and was completed September 9, 1897. Under this contract 187,111.4 cubic yards was removed from the channel and basin, of which amount 58,249.4 cubic yards was removed during the fiscal year.

By hire of labor and purchase of materials in accordance with law 38 linear feet of pile revetment was built to connect the north and south arm of the north pier with the Elgin, Joliet and Eastern Railway Company's revetment, the shore line in the harbor was riprapped for a distance of 360 feet, beginning at a point 40 feet from the north face of the south pier, 236.5 cords of stone being used for that purpose, and repairs to the piers were made and are still in progress.

The repairs to the north pile pier consist in cutting down 385 linear feet of the north and south arm to the water surface, bolting in place new white oak wales 0.5 foot below datum, and in building thereon a pine-timber superstructure 6 feet in height; in renewing the sheet piling along 188 feet of the channel side of north pier, and in refilling the north pier at places where undue settlement had occurred, 69.8 cords of stone being used for this purpose.

Repairs to the shore end of the south pier are now in progress, and will probably be completed in July.

Remarks.—The project of improvement has been completed, but the city of Waukegan is now engaged in dredging a channel midway between the piers, 60 feet wide and 18 feet deep below the datum plane of harbor improvements, and this depth is to be continued through the basin and into the adjoining slip, formerly known as the American Mortar Company's slip. Extensive improvements are also being made in this slip by the Elgin, Joliet and Eastern Railway Company, which has succeeded to the interests of the American Mortar Company.

In accordance with the terms of a lease from the Secretary of War to the city of Waukegan, dated September 4, 1897, granting to the city of Waukegan the use of a portion of the Government land, a description of which is given in Annual Report Chief of Engineers for 1897, page 2707, the city of Waukegan has built a substantial pile dock along the westerly harbor line, extending southerly a distance of about 567 feet.

The harbor piers, as well as the channel between them, is subject to deterioration, and repairs will be needed from time to time.

Estimate for fiscal year ending June 30, 1900.

For repairs of harbor piers	$2,000
Dredging for maintenance of channel	3,000
Contingencies	500
Total	5,500

An appropriation of $5,500 for maintenance of existing works is recommended for the fiscal year ending June 30, 1900.

Money statement.

July 1, 1897, balance unexpended	$16,475.76
June 30, 1898, amount expended during fiscal year	14,499.51
July 1, 1898, balance unexpended	1,976.25
July 1, 1898, outstanding liabilities	12.25
July 1, 1898, balance available	1,964.00
Amount that can be profitably expended in fiscal year ending June 30, 1900, for maintenance	5,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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Appropriations.

Act of—	
August 30, 1852, for breakwater (outer)	$15,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	20,000
July 5, 1884	20,000
August 15, 1886	20,000
August 11, 1888	25,000
September 19, 1890	35,000
July 13, 1892	25,000
August 18, 1894	20,000
June 3, 1896	20,000
Total appropriation for harbor	230,000
Appropriation for outer breakwater (1852)	15,000
Total for present harbor	215,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1897.

[Furnished by the mayor of Waukegan, Ill.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest lighthouse, Waukegan, Ill.

Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Beer	1,750	Eggs	19
Cattle	150	Flour	2,175
Fish	200	Furniture	230
Iron and steel	9,725	Hay	500
Leather	200	Hides	260
Merchandise (general)	106,545	Iron and steel	85,000
Oil	360	Lath	275
Sash, doors, and blinds	375	Lime and cement	725
Sheep	80	Lumber	7,200
Wire	75,000	Malt	380
Wool	25	Marble	1,000
		Merchandise (general)	155,536
Total	194,410	Mill stuffs	1,200
		Oats	80
IMPORTS.		Oil	4,189
		Plaster (land)	250
Agricultural implements	37.5	Posts (fence)	539
Apples	37.5	Potatoes	30
Bark (tan)	550	Salt	25
Barley	470	Sheep	80
Beer	881	Shingles	150
Brick	600	Stone	2,100
Butter	2.5	Ties (railroad)	700
Chairs	500	Wagons and carriages	38
Cheese	5	Wood	4,400
Coal and coke	80,000		
Corn	140	Total	351,294.5

II 21.

IMPROVEMENT OF FOX RIVER, WISCONSIN.

Original condition.—The Fox River rises in Columbia County, Wis., and flows generally westward. Near Portage City it turns northward, then eastward into Lake Winnebago, the latter being about 28 miles long and 10 to 12 miles wide. From Lake Winnebago the Fox flows northward into Green Bay, an arm of Lake Michigan.

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The Fox and Wisconsin rivers, separated at Portage City by a distance of only 2 miles, were the early means of communication between the Great Lakes and the Mississippi.

The fall in the river from Portage City to Lake Winnebago, 110 miles, is about 30 feet, and from Lake Winnebago to Green Bay, 35 miles, is about 170 feet. From mouth of Fox River (Oshkosh) to Menasha is 18 miles.

The Upper Fox has a small discharge and flows through extensive marshes and lakes; near Lake Butte des Morts it unites with the Wolf River, the latter having a much larger discharge than the Fox. The Lower Fox carries off all the water brought down by the Upper Fox, the Wolf, and other small streams, a discharge of 900,000 cubic feet per minute having been known. The average low and high water discharges have not been accurately determined. A low-water discharge of 2,320 cubic feet per minute is given.

From Lake Winnebago to Depere the river was obstructed by rapids, and at places portages had to be made.

In 1846 Congress granted to the State of Wisconsin, on its admission to the Union, a quantity of land for the purpose of improving the navigation of the Fox and Wisconsin rivers in the Territory of Wisconsin, and of constructing the canal to unite the said rivers at or near the portage.

To carry out the object of this act, the State of Wisconsin established in 1848, by act of legislature, a board of public works, which began the work of improvement and carried it on until 1853, when all the property and franchises were transferred to the Fox and Wisconsin Improvement Company. After various vicissitudes, financial and otherwise, the entire property was sold in 1866 to the Green Bay and Mississippi Canal Company, and finally by this company in 1872 to the United States for $145,000, with the exception of personal property, water-power privileges, and the lots or parcels of land belonging to the water powers. The deed of transfer was indefinite in its terms, and so many questions have arisen concerning property and franchises that it is impossible to tell at this time without considerable research what the deed actually conveyed.

At the time of transfer in 1872, there were on the Upper Fox 4 locks, 4 dams, 1 canal; on the Lower Fox 18 locks, 9 dams, 8 canals. The project of the board of public works, State of Wisconsin, recommended the construction of canals, 40 feet wide at bottom, with 4 feet depth at usual low water, and locks 125 feet long between gates and 30 feet wide in the chamber.

The plan to be carried out by the Fox and Wisconsin Improvement Company was to make the Lower Fox of sufficient capacity to allow the free passage of boats drawing 4 feet of water, and the Upper Fox of boats drawing 2 feet at ordinary low water. This plan required the enlargement of the locks to 160 feet long, 35 feet wide, with 5 feet depth on the miter sills.

Object.—The improvement of the Wisconsin River having been abandoned, the present object is to obtain a navigable channel from Portage, on the Wisconsin River, to the harbor of Green Bay, 160 miles.

Project.—The original project of 1872 was a continuation of the project to be carried out by the Fox and Wisconsin Improvement Company. The present project is that recommended by the Board of Engineers of May 14, 1886, and is to deepen the Fox River by rock excavation and dredging from Portage to Montello to 4 feet depth, and

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from Montello to Green Bay to 6 feet depth; to widen the river channels to 100 feet throughout; to dredge the channel in the Neenah River, and to remove the bar at the mouth of the Fond du Lac River.

Present works.—The present works are as follows:

	Upper Fox.	Lower Fox.	Total.
Locks	9	18	27
Dams	7	9	16
Canals	4	8	12
Total	20	35	55

Of the locks, 15 are of stone; 14 built by the United States and 1 by the canal company, but repaired by the United States in 1878. The remaining 12 are wooden locks which have been rebuilt and repaired from time to time.

Of the dams, 1 is of masonry, 12 of cribs, 1 of piles and cribs, 1 of piles with moveable weir, and 1 of brush and stone now being changed to a crib dam.

Of the canals, the one at Portage, 2 miles long, is revetted its entire length on both sides with a timber revetment. At Appleton, above the first lock, there is a cement-laid stone revetment wall about 800 feet long and from 16 to 20 feet high. It was built by the United States in 1879–80. Below the guard gate at Kaukauna is a dry-stone revetment wall about 1,200 feet long. It was built by the canal company and may have to be rebuilt in places, as it shows signs of yielding. Also, in the left bank of the fourth level at Kaukauna, there is a core wall of cement masonry 91 feet long, built in 1893–94; in the right bank of the same level, a wall 143 feet long, built in 1893–94, and in the right bank of the fifth level two core walls, one 600 feet long, built in 1893–94, and one built during same year, and extended in 1898 to connect with new waste-weir, having a total length of 403 feet.

Dry-masonry retaining walls were built along right bank of canal above the "combined locks," 521 feet long, 11 feet high, built in 1895 and 1896, and below Kaukauna first lock, 123 feet long, 12 to 14 feet high, built in 1897.

Masonry wasteweirs in the second, third, and fourth levels at Kaukauna were built in 1894–95, to regulate the water in the Kaukauna system.

Depth of water.—The fall from Menasha to Green Bay is about 170 feet, and on the Upper Fox, from Portage to Lake Winnebago, about 30 feet. Previous to any improvements the river was obstructed by rapids and at places portages had to be made.

As stated above, the project contemplates a channel 6 feet deep from Green Bay to Montello and 4 feet deep from Montello to Portage; these channels to have a minimum width of 100 feet.

On the Lower Fox, which is thoroughly canalized, the crests of the dams are uniformly 6 feet above the breast walls of the locks immediately below, and where rapids are passed by means of several locks the breast wall of any one is about the same elevation as the lower miter sill of the lock above. The exception is the lower miter sill of the Menasha Lock, which is 1.5 feet higher than the breast wall of the next lock below, the Appleton First Lock. This condition gives only 4.6 feet of water at the lower miter sill, Menasha Lock, when the river is at a low stage. When

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the river is at a high stage, with a surplus of 1 foot or more flowing over the Appleton Dam, there is 6 feet over the sill. It is impossible to raise the crest of the Appleton Dam, so it will be necessary to lower this sill when the Menasha Lock is rebuilt.

During the last year the water in the Lower Fox and Lake Winnebago has been well maintained at the crest of the dams throughout the year, with few exceptions. This is the second full year this has occurred, and was brought about by the enforcement of Rule 12. The rule was not strictly enforced against the water users at Neenah and Menasha, but they were allowed certain privileges, by the authority of the Secretary of War. For the exceptions thus made attention is invited to the history in the report of Mr. L. M. Mann, assistant engineer, appended to report upon Operating and Care of Locks and Dams on Fox River, Wisconsin; also accompanying hydrographs, etc., showing stages of water, etc.

The violators of Rule 12, Rules and Regulations for the Navigation and Use of Locks and Canals on Fox River, were prosecuted by the United States attorney, Mr. M. C. Phillips, in whose report, herewith appended, further details are given.

During the fiscal year ending June 30, 1898, navigation closed November 23, 1897, and reopened April 8, 1898, on the Upper Fox and Wolf, and April 12, 1898, on the Lower Fox River.

Operations during the fiscal year.—The work done during the year consisted principally in building the Princeton crib dam and removing the old temporary dam and commencing the construction of a permanent crib dam with masonry abutments at Grand River. A harbor of refuge at Stockbridge Landing, on the east shore of Lake Winnebago, was dredged with the amount appropriated for the purpose, but the entrance to the harbor and its banks require protection. Commerce was much benefited by this harbor before its completion. Bars were dredged and snags and other obstructions were removed from the Wolf River between Lake Poygan and New London, according to the project. The result has been to renew navigation on this stream, which had been practically abandoned. A new 70-foot scow, for carrying the pile driver and other purposes, was built. Repairs to plant, boats, and dredges were made. The dredging along the Lower Fox consisted in widening and deepening the channel below Rapide Croche Lock and Kaukauna Fifth Lock, and the canal above Rapide Croche Lock; also the canal above Appleton Second Lock was widened and deepened by removing an old pile revetment below Lake Street Bridge, which had pushed into the canal. The work of boring wells for drinking water at Appleton First and Kaukauna Second locks has been commenced. Further details will be found in the appended report of Mr. L. M. Mann, assistant engineer.

Remarks and recommendations.—The brief statements heretofore made in annual reports upon the improvement of the Fox River do not convey an adequate idea of the conditions existing along the river since the United States assumed control of the works of improvement in 1872, in regard to the great and conflicting interests of private individuals and of the public at large.

During the last two years investigations have been made by this office to determine as far as possible the exact dividing line between the rights of private individuals and those of the United States, and the river and harbor act of June 3, 1896, provided for a thorough investigation of the character, limitations, and description of the property and

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rights of the United States in connection with the improvement of the Fox and Wisconsin rivers, which was intrusted by the Secretary of War to the Hon. Edward S. Bragg, of Fond du Lac, Wis.

A study of the acts of Congress affecting the Fox River and of the financial and engineering history of the improvement will show how the present condition of affairs grew up. It is impossible in this place to review these documents, on account of the space required; moreover, it is believed that a brief statement of conclusions will suffice to show what future legislation is required to definitely fix the rights of all concerned and to eliminate all occasion for disputes.

On October 1, 1872, Maj. D. C. Houston, Corps of Engineers, assumed formal charge for the United States of the property of the Green Bay and Mississippi Canal Company, conveyed by the deed dated September 18, 1872, and described as follows:

> All and singular its property and rights of property in and to the line of water communication between the Wisconsin River aforesaid and the mouth of the Fox River, including its locks, dams, canals, and franchises.

The deed especially reserved to the company the following:

> First. All the personal property of said company. * * *
> Second. Also all that part of the franchises of said company, viz: The water powers created by the dams and by the use of the surplus water not required for the purposes of navigation, with the rights of protection and preservation appurtenant thereto, and the lots, pieces, or parcels of land necessary to the enjoyment of the same, and those acquired with reference to the same; all subject to the right to use the water for all purposes of navigation, as the same is reserved in leases heretofore made by said company.

The indefiniteness of this deed, along with the indefiniteness of United States law governing the use of navigable waters, has resulted in the frequent, in fact constant, disregard of the rights of navigation, and the diversity of interests along the river has been a source of constant litigation between individuals.

It may be said that by virtue of this deed the United States possesses a joint ownership with private corporations of the bed, banks, and water of the Fox River; the United States owning the locks, dams, canals, and the right to use the water for all purposes of navigation, the Green Bay and Mississippi Canal Company owning the water powers created by the Government dams and by the use of the surplus water not required for the purposes of navigation.

No accurate description has ever been made of the property transferred by the deed, and no accurate distinction drawn between the franchises retained by the Green Bay and Mississippi Canal Company and those transferred to the United States.

The only official mention of the water power along the Fox River at the time of transfer is contained in a report by Major Houston, dated February 26, 1872, and taken from the testimony of Morgan L. Martin before the board of arbitrators. The water power was distributed as follows: At Appleton 5,000 horsepower, Cedars 1,000 horsepower, Little Chute 2,500 horsepower, Kaukauna 2,500 horsepower, Rapide Croche 1,500 horsepower, Little Kaukauna 750 horsepower, at other points 750 horsepower; total, 14,000 horsepower. About 2,000 horsepower was leased: At Portage 50, at Montello 25, at Appleton and other points below 2,000 horsepower, leaving 12,000 horsepower not leased. Major Houston makes no mention of Neenah and Menasha and DePere. The immense growth of the manufacturing interests dependent upon the water powers since 1872 is shown by tables given on page 2732, Annual

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Report of Chief of Engineers for 1897. It is estimated that the water powers are worth to their owners not less than $1,000,000 per year. The output of the mills is not accurately known, but it is enormous. The entire water power of the Fox River is now under the control of a single company, known as the Neenah and Menasha Water Power Company, which apportions to its members or stockholders the water to be used from time to time according to the stage of the river. Until the formation of this company the diversity of interests was so great that at one time or another each water-power user was deprived of his just rights, and until the promulgation, February 15, 1895, of the United States Regulations for the Navigation and Use of Locks and Canals on the Fox River, prescribed by authority of section 4, river and harbor act of August 17, 1894, the lack of control by the United States was so apparent that the rights of navigation were absolutely ignored by water-power users, to such an extent at times that the canals were actually empty. A suit in equity was filed November 8, 1886, in the United States court of the eastern district of Wisconsin against certain corporations at Neenah and Menasha, to restrain them from taking water for hydraulic power or other purposes when the level of the water in Lake Winnebago is at or below the crest of the Menasha Dam. This suit is still pending.

Paragraph 12 of the regulations above referred to prohibits any party or parties from drawing the water from any portion of the Fox River or its canals and channels to such an extent as to lower the water surface in any pool below the crest of the dam at its foot. The rule went into effect May 11, 1895, and resulted in closing all the mills because of the then low stage of the water. On account of the hardships of this condition of affairs, the Secretary of War, on May 22, 1895, allowed the mills to draw half the flow of the river. On July 15, 1895, this order was revoked and rule 12 enforced. On September 16 the mills were allowed to draw water until the lake fell to 18 inches below the crest of the Menasha Dam. On March 23, 1896, the mills were allowed to draw only 25,000 cubic feet per minute. On May 5 the water had risen to the crest of the dam, and on June 8 was 2.92 feet above the dam. On August 21 the mills were obliged to discontinue drawing water. On September 30 they were permitted to draw the lake to 6 inches below the crest of the dam. On March 11, 1897, the limit was made 12 inches below the crest, and to continue until the opening of navigation.

Inasmuch as the contention between the United States and the water-power users concerns the use of the water flowing in the river, it would seem that the first thing to be determined is the respective rights of the parties in that particular. This matter was brought to an issue by the equity suit of 1886, which is unfortunately still in court. If the rights of the United States alone can be determined, and if they are found to be sufficient for all the needs of navigation, then no further legislation is necessary. The deed of conveyance of 1872 reserved to the Green Bay and Mississippi Canal Company the water powers created by the dams and by the use of surplus water not required for the purposes of navigation. The first inference from this reservation is that two things create a water power: First, dams; second, use of the surplus water not required for navigation. The second inference is that water required for navigation is not surplus and is the property of the United States. The ownership of the dams is clear; therefore it remains to determine what quantity of water is required for navigation. This quantity has not been determined by judicial decision or by act of Congress except so far as may be

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inferred from the fact that funds have been appropriated by Congress for continuing the improvement of the river. These funds have been expended upon a project recommended by a Board of Engineers under date of May 14, 1886, and which fixed the elevation of the crest of the Menasha Dam and the width and depth of channels in the river and canals. These points once fixed, it follows that any alteration of the water surface by any other agency resulting in a lowering of the water surface below its natural level is an injury to the carrying out of the project, and consequently to navigation, which for successful operation in a system of canals and locks must be able to rely upon a constant depth of water.

Assuming then that the quantity of water needed to fill the levels of the river to the crests of the dams is that required for navigation, all other water is surplus and belongs to the water-power owners, and would flow over the dams if not drawn through mill flumes or tail gates.

A strict adherence to this principle would require the mills to so adjust their draft as to constantly maintain the water surface at the exact crest of the dams, requiring such constant watchfulness and care on account of the varying discharge of the river, that even if the mills were so disposed it would be almost impossible to succeed. It is certainly impossible to conduct a business under such uncertain conditions. To obviate this difficulty, permission has recently been given to various mill owners to maintain flushboards on the Government dams on their own responsibility, giving them thus a certain lee way for variation in the stage of the river. It should be said here parenthetically, that water flowing over the dam is wasted, from the mill owners' point of view.

At some of the dams it has been possible for the mill owners to maintain the flushboards without injury to the rights of others. At Neenah and Menasha, however, it has been considered impossible to assume that responsibility, and constant application has been made to the War Department to draw the water down during low stages of the river. During the last few years the mills have been installing steam plant for use at these periods, in fact nearly all the mills are now so provided.

The river and harbor act of June 3, 1896, contains a provision in reference to this matter as follows:

> And the Secretary of War is directed, by the use of flushboards or otherwise, to make avail of all the natural flow of water and prevent waste thereof, to the height to which the right of the United States to hold the same has been established and without interfering with private rights.

There are two limitations placed upon the action of the Secretary of War in carrying out the provision of the law quoted, namely, the water is to be raised "to the height to which the right of the United States to hold the same has been established," and "without interfering with private rights."

The rights of the United States to the use of water flowing in the Fox River are limited to the requirements of navigation, and these are held to be the maintenance of the water in the levels at the crests of the dams as they exist and the use of water for lockages.

By an act approved March 3, 1875, Congress authorized the ascertainment and payment of damages resulting from the overflow of private property caused by the dams in the Fox River. These claims were adjudicated by the courts, and each claimant signed a release

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based upon the judgment of the court, which released the United States from any further claims for damages so long as the Menasha Dam is maintained at its present height. It follows, therefore, that the height to which the United States may hold the river is the present height of the dam, and that any raising of this height would subject the United States to further claims for damages. It has been the opinion of various officers in charge that there is a strong probability of damage being inflicted upon private property by reason of the flowage of water, so that the terms of the law can not be carried out "without interfering with private rights."

It is not to be understood, however, that the surface of Lake Winnebago must never be allowed to rise above the crest of the Menasha Dam. It is practically impossible to secure such a condition of affairs, because the quantity of water flowing in the river during floods is greater than the capacity for discharge. When the dam was rebuilt in 1886 it was decided, in order to avoid flowage, to put in sluice gates instead of lowering the crest, and the actual height to which the water might rise before sluicing was begun was determined by Major Marshall by comparing all high-water marks and determining that their average was 21 inches above the crest of the dam, and that the water was to be kept below that limit by sluicing. This rule has since been followed, and does not constitute a violation of the releases above mentioned, because artificial means are not used to hold the water above the crest.

While it may be assumed that navigation requires the water surface to be maintained at the crests of the dams, it may also be said that when the river is closed by ice, generally from November 15 to April 10, navigation is impossible, and therefore requires no water whatever. The objections to drawing the water off at this period to any great extent is that the wooden structures are subjected to alternate wetting and drying, causing rapid rot, and that the stone structures are subjected to injury by the entrance of ice in the joints. The greatest objection lies in the difficulty of determining whether the levels will be full at the opening of the next season of navigation. The discharge of the river varies enormously from month to month, as well as from year to year. Accurate observations are now being taken, which in time will furnish data to determine the average discharge and other quantities in connection with the hydraulics of the river. In the meantime it can only be said that it is unsafe, as far as navigation is concerned, to depend upon a heavy rainfall just preceding the opening of navigation for filling Lake Winnebago to the crest of the Menasha Dam.

The lower miter sill of the Menasha Lock is at such a level that during the low-water season there is but 4½ feet of water over it. It was probably placed at that elevation originally, because the condition of the rapids below backed the water up to a higher level than takes place since the rapids have been improved by excavating a channel through them. The Menasha Lock is built of wood and stone and will require rebuilding within a year, and when rebuilt the lower miter sill can be placed at the proper elevation to give 6-foot draft over it, as called for by the project, with but slight increase in cost. While it may be said that for the time being 6-foot navigation is interrupted at Menasha Lock, yet the traffic between Green Bay and points below Menasha, along the Lower Fox, and also between points above Menasha, on Lake Winnebago, the Wolf and Upper Fox rivers, is great enough to justify the maintenance of a depth of 6 feet at all points along the river.

While the law is sufficiently clear it is not comprehensive enough to

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avoid injury to the great manufacturing plants that have grown up in the Fox River Valley. There does not appear to be any further legislation required to protect the interests of navigation on the Fox River if the water is not drawn by the mill owners below the crests of the dams. Legislation or permission by the War Department to raise or hold the water higher than the crests of the dams, is entirely in the interests of the users of surplus water not needed for purposes of navigation, and should be secured for their purposes and at their expense. The maintenance of flushboards on all the dams below Menasha, where water is used by mills under the existing permits of the War Department, and at the expense and risk of the mill owners, secures a sufficient stage of water for the mills. Similar permission to place flushboards on the Menasha dam was granted the Neenah and Menasha Water Power Company, but declined to be availed of by that company, owing to their fear of creating claims for flowage of lands by backwater. It is believed that the placing of flushboards up to 8 inches in height on the Menasha dam will cause little damage by flowage to land on the shores of Lake Winnebago, and if there is danger of such flowage the Neenah and Menasha Water Power Company, controlling all the water to be used by the mills on the Lower Fox River, should not expect the Government to enact legislation that will secure additional height to the Menasha Dam and make itself liable for any flowage damages that might arise.

One level of the Fox River improvement is maintained by two dams, one of which is owned and operated by the United States and the other by a private corporation. The level referred to is that above Menasha and the dams are respectively known as the Mensha Dam and the Neenah Dam. The exact legal status of the Neenah Dam is not clear, and the amout of control which the United States may exercise over it is therefore not definite. In times of high water it might become necessary to operate the private dam. No conflict of authority has yet occurred, because the owners of the dam have complied with every request from this office when it was believed to be necessary to open the sluice gates. It is to the interest of the United States, however, to secure absolute control over the dam by purchase.

The recommendation to purchase a chain-bucket dredge at a cost of about $35,000 is renewed. It is believed that the cost of dredging will be much cheapened and the completion of the work hastened.

Estimate of cost of completing project for improving Fox River.

Rebuilding Menasha Lock	$16,000.00
Dredging 1,849,594 cubic yards in Upper Fox, at 8 cents	147,967.52
Total	163,967.52

Money statement.

July 1, 1897, balance unexpended	$35,596.43
June 30, 1898, amount expended during fiscal year	23,086.19
July 1, 1898, balance unexpended	12,510.24
July 1, 1898, outstanding liabilities	1,240.64
July 1, 1898, balance available	11,269.60
Amount (estimated) required for completion of existing project	180,866.48
Amount that can be profitably expended in fiscal year ending June 30, 1900	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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List of appropriations made by Congress for the improvement of the Fox and Wisconsin rivers, Wisconsin.

Act of—	
March 2, 1867, for snag boat on Wisconsin River	$40,000
July 10, 1870, for improving Wisconsin River	100,000
June 10, 1872, for purchase of works on Fox River from Green Bay and Mississippi Canal Company	145,000
March 3, 1873, for improving Fox and Wisconsin rivers	300,000
June 23, 1874	300,000
March 3, 1875	500,000
August 14, 1876	270,000
June 18, 1878	250,000
March 3, 1879	150,000
June 14, 1880	125,000
March 3, 1881	125,000
August 2, 1882	200,000
July 5, 1884	160,000
August 5, 1886, for improving Fox River	56,250
August 11, 1888, for improving Fox River	100,000
September 19, 1890, for improving Fox River	100,000
July 13, 1892, for improving Fox River	75,000
August 18, 1894, for improving Fox River	37,500
June 3, 1896, for improving Fox River	37,500
Total	**3,071,250**

COMMERCIAL STATISTICS.

List of articles transported on Fox River, Wisconsin, during season of 1897.

Articles.	Quantity.	Articles.	Quantity.
	Tons.		*Tons.*
Brick	9,974.50	Lumber	11,227.25
Cedar posts	1,513.50	Oil	196.50
Coal	13,747	Paper	242
Cord wood	18,768	Pulp wood	11,008
Drain tile	250	Piles	312
Flour, grain, and mill stuffs	2,728	Rags, chemicals, etc	1,610
General merchandise	4,634	Salt	1,470
Gravel	1,050	Sand	4,447.50
Grass	400	Shingles	541.50
Land plaster	75	Stone	9,404
Lime	240.50		
Logs	97,842.50	Total	191,235.75

Passengers, 29,616.

List of boats navigating Fox River between Portage and Greenbay, Wis., 1897.

Name of boat.	Draft.	Tonnage.	Class.
	Feet.	*Tons.*	
Evalyn	3	150	Steam.
B. F. Carter	5	110	Do.
J. H. Crawford	2	100	Do.
J. H. Marston	5	75.25	Do.
Fashion	2½	50	Do.
John Lynch	3	50	Do.
D. A. Cady	1½	50	Steam tug.
M. D. Moore	3	50	Do.
Hustler	2	50	Do.
Nettie Denessen	5½	22	Do.
John Denessen	5½	15	Do.
Volunteer	5½	17	Do.
D. L. Libbey	5	17	Do.
Morning Bell	4½	7	Do.
Georgie	5½	78	Sailing scow.
Wm. Finch	5½	49	Do.

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List of boats navigating Fox River between Portage and Greenbay, Wis., 1897—Cont'd.

Name of boat.	Draft.	Tonnage.	Class.
	Feet.	*Tons.*	
Sandy	5	150	Towing scow.
Venture	6	91	Do.
Long Tom	5	145	Towing barge.
Jumbo	5½	97	Do.
Hustler (1)	3½	90	Do.
Hustler (2)	3½	80	Do.
Okobaji	4½	10.99	Steam yacht.
Anna M	2½	10	Do.
Theresa	3½	.....	Do.
Cambria	4	.....	Do.
Gagelle	3½	.....	Do.
Irma	3½	.....	Do.
Nia	3½	.....	Do.
Swallow	3½	.....	Do.

NOTE.—There are also a number of small pleasure yachts besides those mentioned.

Number of lockages on Fox River, Wisconsin, for the calendar year 1897.

No.	Lock.	Lockages.	No.	Lock.	Lockages.
1	Depere	454	16	Appleton, second	351
2	Little Kaukauna	351	17	Appleton, first	486
3	Rapide Croche	303	18	Menasha	425
4	Kaukauna, fifth	360	19	Eureka	581
5	Kaukauna, fourth	357	20	Berlin	472
6	Kaukauna, third	356	21	White River	182
7	Kaukauna, second	362	22	Princeton	185
8	Kaukauna, first	361	23	Grand River	122
9	Little Chute, fourth a	361	24	Montello	67
10	Little Chute, third a	361	25	Governor Bend	100
11	Little Chute, second	293	26	Fort Winnebago	138
12	Little Chute, first	293	27	Portage	94
13	Cedars	269			
14	Appleton, fourth	304		Total	8,331
15	Appleton, third	344			

a Combined.

REPORT OF MR. M. C. PHILLIPS, UNITED STATES ATTORNEY.

OSHKOSH, WIS., *July 9, 1898.*

CAPTAIN: I have to report concerning legal matters connected with the Fox River, Wisconsin, and the Sturgeon Bay and Lake Michigan Ship Canal, and other river and harbor works on Lake Michigan for the year ending June 30, 1898, as follows:

United States *v.* Appleton Paper and Pulp Company: Violation of Rule 12 of United States Regulations for the Use and Navigation of Locks and Canals on the Fox River, Wisconsin. Fine of $100 on plea of guilty,

United States *v.* Manufacturing Investment Company at Appleton, Wis.: An order of discontinuance entered on application of plaintiff without prejudice.

The remaining so-called water cases on the Fox River are still pending.

United States *v.* Peter C. Batchelder: Violation of Rules 3, 7, and 9 of United States Regulations prescribed by the Secretary of War for the Navigation and Use of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin. Fine of $1 and costs on a plea of guilty.

United States *v.* Oley Groh, at Sheboygan, Wis.: Violation of section 6, act of September 19, 1890. No indictment found by the grand jury.

United States *v.* Theodore Gunderson, at Sheboygan, Wis.: Violation of section 6 of the act of September 19, 1890. On trial verdict of not guilty, because of lack of location of harbor limits.

United States *v.* John Nicholsen: Violation of Rules 3 and 9 of United States Regulations prescribed by the Secretary of War for Sturgeon Bay Canal. Indictment returned by the last grand jury, and trial pending.

Yours, truly,

M. C. PHILLIPS,
United States District Attorney, Eastern District, Wisconsin.

Capt. GEORGE A. ZINN.

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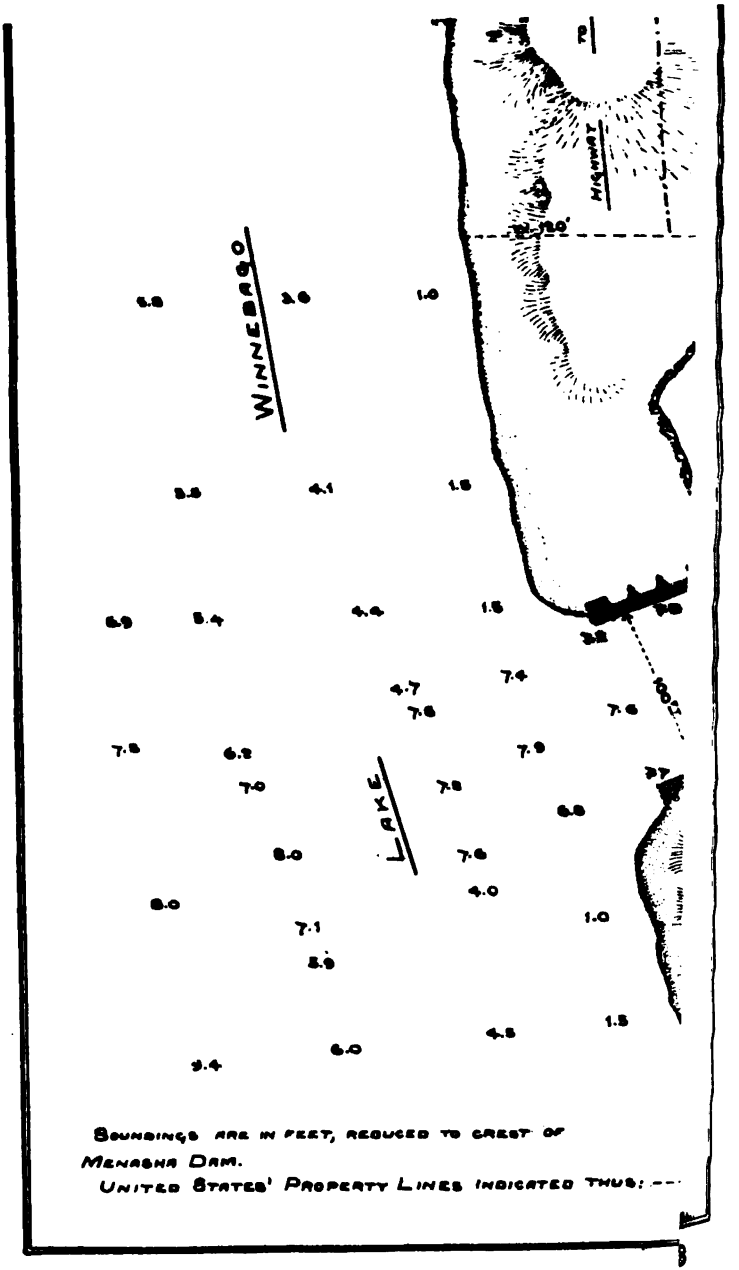

To accompany Annual Repo
fiscal year ending June 30, 1

Captain, Cor

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
FOX RIVER IMPROVEMENT,
Oshkosh, Wis., June 30, 1898.

TAIN: I have the honor to submit the following report of operations on "Im-ıg Fox River, Wisconsin," from Portage to Greenbay, for the fiscal year ending 30, 1898:

work done during the year consisted principally in continuing construction of eton crib dam; commencing construction on Grand River crib dam; construct- harbor of refuge at Stockbridge Landing, east shore of Lake Winnebago; ring and removing snags, etc., from Wolf River; building a new 70-foot scow; ring boats and dredges; dredging channel below Kaukauna fifth and Rapide he locks and canal above Rapide Croche and Appleton second locks; construct-wells at Appleton first and Kaukauna second locks.

BOR OF REFUGE, EAST SHORE OF LAKE WINNEBAGO (STOCKBRIDGE LANDING).

accordance with project approved November 4, 1896, work was commenced July 97, by dredge No. 2, with steam tug *General G. K. Warren* as tender. The entrance was made 100 feet in width, and harbor dredged to an average depth of 7½ feet w the crest of Menasha dam. Sand, clay, gravel, and bowlders were removed to amount of 39,351 cubic yards. Of this, 30,103 cubic yards was dumped by scows he lake and the rest piled on banks or in the water; 6,968 cubic yards was ndled. Dredging was completed October 16.

laterial was dumped for filling on shore north of entrance and leveled by teams l scrapers. Protection piers were built 75 feet long on the north and 100 feet on south side to prevent entrance banks from washing. Each consists of one row piles, about 5-foot centers, tied back with iron rods to single piles, and with oak ings. Fifty-nine were driven in all, including two guide clusters in the lake, ler agreement with Mr. R. Booth, Oshkosh. Brush mats were weighted with stone l packed behind piles, completing the work, after delays through stormy weather, December 31, 1897.

lthough the amount appropriated was small, very good results were obtained to satisfaction of all parties around the lake, both as to the location and the improve-nt. As soon as an entrance was dredged large enough to contain the dredge and teamboat, a regular line of boats was established between Oshkosh and this har-r. From August to the close of navigation, 1897, about three months, 400 tons of ight and 3,600 passengers had been imported and exported, a surprising result. is will probably be greatly increased this season.

Upon examination of the harbor this spring, after the fall and spring storms and avy ice shoves, it was found that but little damage had been done. The two clus rs of piles in the lake have been shoved out by the ice, which was expected. Con-derable caving occurred on the inside of the land spit north of the entrance, by an dy, undoubtedly. As this land spit is the principal protection to the harbor, it ould be well protected from further erosion. It can be easily and cheaply done y close piling with loose stone backing and then if planked over will give a good ublic landing. When the pier, as planned, south of the harbor entrance is provided, good permanent harbor will be established. Map showing the plan of harbor and lative location accompanies this report.

REMOVAL OF BARS AND SNAGS FROM WOLF RIVER, WISCONSIN.

In accordance with project approved November 7, 1896, work was commenced on September 2, 1897, by dredge No. 5, attended by steam tug *Boscobel*. Bars were dredged and snags and other obstructions removed between New London and Lake Poygan, 47 miles, giving a channel of 75 feet least width, and 4 feet deep at mean low water. A dam was also thrown across Mill Cut, an outlet of the river, to divert the water into the main stream. There were removed 54 piles, 277 trees, and 1,716 snags; 2,520 cubic yards of material was placed in dam and 20,202 cubic yards of sand and clay dredged from different bars, as follows: New London Bar, 11,754 cubic yards; Little Wolf Bar, 1,365 cubic yards; Upper Mukwa Bar, 1,413 cubic yards; Lower Mukwa Bar, 405 cubic yards; Tom Wall Bar, 5,265 cubic yards. Total work was a cut 4,530 feet long, 75 feet wide, and 9 inches to 4 feet deep. About 70 feet of wreck of steamer *Tom Wall*, an old obstruction to navigation near head of Hill Cut, was removed, and work completed on October 30.

Comparatively a large amount of work was done with the small fund available. A fine river, 1½ times as large as the Fox, was opened up, available now to naviga-

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tion from Oshkosh to New London, a distance of 56 miles. A large, new industry, started in Oshkosh last fall (the Wisconsin Grass Twine Company) had the advantage of this improvement immediately after it was completed. This company brought down 400 tons of baled grass to their factory before the close of navigation. Had the improvement not been made, the amount of shipment would probably have been much curtailed. I understand the amount of grass to be shipped this season is estimated at 5,000 tons. A regular line of boats has also started on the Wolf this spring and there are good prospects for further development on this river. A chart of the river to New London, compiled and corrected in this office, accompanies this report.*

DREDGING LOWER FOX.

[See also O. and C. report.]

By dredge No. 2, channel below Rapide Croche lock.—This was dredged in May, 1898, the channel being widened from 10 to 30 feet on each side, and deepened from 6 to 18 inches; 945 cubic yards of clay and stone were removed and banked or dumped in scows. The work extended from 800 feet to about half a mile below the lock.

Canal above Rapide Croche lock.—This was widened on each side from 10 to 30 feet and deepened from 6 to 18 inches for its whole length; 1,684 cubic yards of clay and muck were removed and banked or dumped in scows.

Channel below Kaukauna fifth lock.—The lower approach was widened from 20 to 30 feet on left side by removing 1,204 cubic yards of muck, and the right side of channel deepened from 6 to 12 inches at about half a mile below lock, 1,643 cubic yards being removed.

Canal above Appleton second lock.—The old pile-and-plank revetment on the right side, below Lake Street Bridge, which had been pushed into the canal by the bank, was torn out and channel dredged to its former width, material being removed in dump scows. A revetment to protect bank at this place was rebuilt by the city of Appleton.

CONSTRUCTION OF SEVENTY-FOOT SCOW.

This decked scow, intended for general use, was built at Oshkosh under agreement with Mr. George Ryan. It is 70 feet over all, 18 feet wide, and 4 feet deep, and is provided with a rudder and two grousers, the gear for the latter being taken from condemned dredge No. 6. The scow was completed August 12, 1897, and is named *Eureka*.

Materials used were: Oak, 4,688 feet B. M.; pine, 11,850 feet B. M.; bolts, spikes, forgings, etc., 2,616 pounds.

REPAIRS OF BOATS AND DREDGES.

[See also O. and C. report.]

Steam tug Boscobel.—Repairs were made to boiler and machinery under agreement with the Appleton Machine Company.

Dredge No. 2.—Boiler and machinery were repaired under agreement with the Appleton Machine Company, and a new 2-yard dipper, purchased from the Vulcan Iron Works, Chicago, substituted for the old one. This dipper has some improvements and works very satisfactorily.

Dredges Nos. 4, 5, and 7.—Repairs to machinery and dippers were made under agreement with Mr. J. A. Barnes, of Oshkosh.

CONSTRUCTION OF LOCKS, ETC.

Princeton Dam and Fishway.—Work was begun in June, 1897, on new permanent dam to supersede old one of brush and stone. One acre of land was purchased for the right abutment from Mr. Frank Zulke for $40, lying in lot 2, sec. 35, T. 16 N., R. 11 E.

The new dam is built 175 feet below the old one, is 180 feet long between abutments, 29 feet 8 inches on the base and 12 feet 6 inches high, and composed of timber cribs filled with rip-rap, being similar to the dams at Berlin and White River, with two lower aprons. Abutments are of cut stone on timber cribs, and pile-and-brush protections extend on each bank below for 160 feet. Crest of dam is 6 feet above

* Not forwarded.

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coping of breast wall of lock, or 0.57 feet below crest of old dam. This difference is counterbalanced by the use of flushboards.

Excavation.—Excavation was done by dredge No. 7, attended by steam tug *Fox*, the dredge having first to cut her way to the site through sand bars. Material removed for dam, abutments, and protections, chiefly sand, was partly banked up and partly put in scows and dumped in a basin dredged for that purpose 1,300 feet below, this being cheaper than rehandling material. The bottom of the crib sites was leveled off with a scraper.

Cribs.—Cribs for dam proper were commenced on ways on bank in three sections, each 60 feet long, 29 feet 8 inches wide, and three courses high. These were launched, lined up together near the site, and built up as a continuous crib, 180 feet long, as far as top course of ties. The whole was then towed to place, a temporary deck put on and loaded with stone, and the crib sunk. The left abutment crib was first placed and sunk for a guide, and the right abutment crib brought up and sunk after dam was in place. The dam crib was filled with rubblestone, deck stringers placed, 3-inch decking put on, and framing finished. The method proved very successful, although the sinking of the 180-foot crib in a slight current was attended with some difficulty. The lock gates were opened during the operation to reduce the current. Cribs for abutments were made and placed in a similar manner, except that they were built 5 feet high on ways and made full length of 40 feet. On upper sides of all cribs, Wakefield sheet piling, 18 feet long, was sunk with a water jet and then driven to place.

Masonry.—The limestone superstructures of the abutments are built on the cribs, which are sunk below water line, and each is 40 feet long, 6 feet 9 inches high, 4 feet in average thickness, and with a wing wall running back 15 feet. The stone was brought from quarries at Kaukauna by steam tugs *Fox* and *Boscobel*, and was dressed at the site. It was laid with Louisville cement and pointed with Portland.

Protections.—Trenches about 10 feet wide were dredged to a level with bottom of cribs for protections below the dam, and piles were driven by water jet. Each protection consists of two rows of piles 10 feet apart, with piles 8 feet apart along the lines; 1-inch tie-rods and oak wales brace the whole together. Brush mats and bundles, weighted with stone, fill up the trenches and spaces between.

General.—The old dam was removed by dredge while backing the new one; material was placed for filling behind abutments and protections. A dike 61 feet wide, protected in part with brush and stone, was built from right abutment to high ground, to prevent water cutting round.

The dam was closed up on September 30, and 18-inch flushboards (since reduced to 12-inch) were placed on crest; pool filled same day.

The dam is provided with a standard fishway, in accordance with law.

The entire construction was finished on November 5, 1897.

The following is a summary of labor and material:

Dam:		
Timber and plank	feet B. M..	125,236
Driftbolts, spikes, etc	pounds..	9,981
Stone filling	cords..	122
1¼-inch gas pipe for flushboard pins	pieces..	32
Abutments:		
Timber and plank	feet B. M..	54,290
Stone filling	cords..	38
Driftbolts, spikes, etc	pounds..	3,971
Cut-stone masonry	cubic yards..	125½
Louisville cement	barrels..	30
Portland cement	do....	1
Fishway:		
Lumber	feet B. M..	1,661
Elm piles	number..	6
Iron	pounds..	158
Protections:		
Timber for wales	feet B. M..	4,373
Elm piles, 26 feet long	number..	84
Tie-rods, etc	pounds..	1,546
Brush	cords..	134½
Mat poles	number..	2,564
Yarn	pounds..	98
Stone filling	cords..	52½
Grading and dredging:		
General grading	total cubic yards..	3,439
Excavation by dredge	do....	34,767

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Grand River Dam and Fishway.—Work was also begun to replace the old and only remaining temporary brush dam by a permanent crib dam, as called for in the project and provided for in the last river and harbor bill of June 3, 1896. The dam is to be built in accordance with plan dated March 19, 1898, with length changed from 140 feet to 120 feet, as approved by Capt. George A. Zinn, Corps of Engineers, U. S. A. It will be of timber cribs filled with stone and masonry abutments, similar to dams at Princeton, White River, and Berlin, excepting that the lower apron is omitted and provision is made for six sluice gates in the center. Other changes in the former plan were made to save material and reduce the cost. A drawing showing sections of these crib dams on the Upper Fox, with fishway, accompanies this report.*

A survey and map of the United States property and the land to be purchased for the left abutment of dam was made in May. The new dam is located about 120 feet below the old one, and arrangements for the purchase of 0.56 acre of land from Mr. John Barritt, for $11.60, lying in lot 9, sec. 26, T. 15 N., R. 10 E., have been made for the left abutment, the right abutment lying on Government property.

Quarter boat, scows, and material which has all been purchased, were taken to Grand River during the first part of May, and actual work on the dam was commenced May 19, under the direction of Mr. Peter Diedrich, master carpenter. Dredge No. 7 was towed there from White River lock, May 23, and dredged foundation for abutments and dam, removing 8,036 cubic yards. She also dredged a channel and place for launching cribs, removing 2,620 yards for this purpose. On her way to Grand River, she was obliged to remove 1,387 cubic yards at mile post 64, Lake Apuckawa, and 345 cubic yards from obstructing bars in the old river to allow her to pass around to the site of the new dam.

A footbridge across old dam was built, and ground graded and ways laid for construction of cribs. Seventy-nine thousand nine hundred and ninety-three feet B. M. pine and 1,179 feet of oak timber and plank has been framed for cribs of right and left abutments and dam proper. Of this, 22,542 feet B. M. has been placed and secured for the right abutment crib. This crib was built up to eighth course on ways, then launched, towed to site, and built up to twelfth course, after which it was sunk in place with 18¼ cords of stone and decked with plank. Thirty sheet piles, made with wire nails and clinched, instead of bolts, were placed on upper side of this crib with jet and pile driver, operated by crew of steam tug *Fox*, completing right abutment crib. The two 60-foot cribs were built up three courses on the ways, the floors planked, and cribs launched. The two cribs were then brought into line, joined, and the fourth and fifth courses added. The vertical sheathing on the lower side and oak plank on the lower apron were then placed and spiked. The uprights for fishway were also placed before launching. Four hundred and fifty-seven superficial feet of dimension stone for masonry in superstructure of abutments were cut. Dredge No. 7 and crew assisted in leveling foundation for right abutment crib, sinking and building up same, sharpening tools, and unloading dimension stone from scows. Thirteen 26-foot piles were driven for right-shore protection below the dam and sawed off 1½ feet above the crest of dam. Six hundred and sixty-four bundles of brush and 560 nat poles were cut, and 140 brush mats made and towed and placed on right bank, 37 of which were sunk in place with two cords of stone.

The steam tug *Fox* and crew fitted out pile driver with the Worthington pump and extra portable boiler, towed same from Berlin lock to dam, drove the sheet piles and piles for protection. This tug and the *Boscobel* loaded and transported timber and other material from Oshkosh, Berlin, and Princeton and three scow loads of dimension stone from Kaukauna, and towed dredge and scows, quarter boat, etc., from Berlin lock. The foundation of this dam is very good, consisting of gray soft marl about 1 foot deep, which becomes hard when exposed to the air, underlaid with red clay. The work is progressing very favorably and will be completed early in the fall. Fishways will be built in this dam and at Montello.

Wells at Appleton first and Kaukauna second locks.—A well was bored at Kaukauna second lock and pipe and pump furnished by agreement with Mr. J. M. Black for the sum of $60. A 4-inch pipe was used and well bored 18 feet through earth and 12½ feet in solid rock. The well shows 15 feet of water, which is good and clear and in sufficient quantity. An agreement has been made with the same party for a similar well at Appleton first lock for $1 per foot, including piping and pump.

Respectfully submitted.

L. M. MANN, *Assistant Engineer.*

Capt. GEORGE A. ZINN,
Corps of Engineers, U. S. A.

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*Not forwarded.

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REPORT RELATIVE TO INVESTIGATION OF THE CHARACTER, LIMITATIONS, AND DESCRIPTION OF PROPERTY AND RIGHTS OF THE UNITED STATES IN CONNECTION WITH IMPROVEMENT OF FOX AND WISCONSIN RIVERS, WISCONSIN.

[Printed in House Doc. No. 389, Fifty-fifth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 22, 1898.

SIR: The river and harbor act of June 3, 1896, provides for making, under the direction of the Secretary of War, "a thorough investigation of the character, limitations, and description of the property and rights of the United States in connection with the improvement of the Fox and Wisconsin rivers."

The Secretary of War appointed Hon. Edward S. Bragg, of Fond du Lac, Wis., to make the investigation aforesaid, and General Bragg submitted his report to the War Department under date of February 15, 1898.

In accordance with the instructions of the Secretary of War, the original report, with original maps,* is submitted herewith, prepared for transmission to Congress, the pressure upon the clerical force being at the present time so great as to preclude making copies of these papers without serious interference with current work.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF HON. EDWARD S. BRAGG.

Hon. RUSSELL A. ALGER,
Secretary of War:

Under the appointment made by your predecessor of date August 7, 1896, referring to me for my action the item contained in the river and harbor act of June 3, 1896, relating to the improvement of the Fox River, Wisconsin, which reads as follows:

> For a thorough investigation of the character, limitations, and description of the property and rights of the United States in connection with the improvement of the Fox and Wisconsin rivers, to be made under the direction of the Secretary of War, upon condition that the owners of any property which may be interested in such delimitation shall pay such proportion of the cost of such investigation as the Secretary of War shall determine, three thousand dollars—

I have the honor, respectfully, to submit the following report:

That so soon as I was able to proceed upon the investigation directed, I gave notice of my purpose to proceed under such appointment to the Green Bay and Mississippi Canal Company, from whom the United States received a conveyance dated September 18, 1872, under and by virtue of a certain act of Congress, entitled "An act for the improvement of the water communication between the Mississippi River and Lake Michigan by the Wisconsin and Fox rivers," approved July 7, 1870, and a report of the Board of Arbitrators duly constituted and acting under and pursuant to said act of Congress, dated November

* The maps which accompanied this report are not reprinted; they are printed in House Doc. No. 389, Fifty-fifth Congress, second session.

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15, 1871, and a report of the Secretary of War thereon dated March 8, 1872, and the further act of Congress, entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," approved June 20, 1872, and in such notice requested a statement of the extent of any right or franchise, which they claimed was reserved to the company under its construction of the deed so given to the Government. And also a like notice to the Neenah and Menasha Water Power Company, at its special request.

The notice to the canal company was given because a construction of their deed to the United States was involved in the investigation committed to me; and to the Neenah and Menasha Water Power Company, because of a claim of right made by them hostile to the Government, to erect and maintain a dam across the south branch of the Fox River leading out of Winnebago Lake.

The canal company, in response to my request under date of March 16, 1897, submitted a summary of their supposed claims and rights, still remaining in the lands, works, and water power existing at the time of the making of their deed to the United States, hereinbefore stated.

By way of inducement to a statement of their present claims of right in the lands, franchise, dams, property, and water power commonly known as the "Fox and Wisconsin improvement," and of the duties and liabilities of the United States under their deed from the company, they assert that prior to the execution and delivery of the deed to the United States by the canal company, the company was the owner of all of the water power created by the works of improvement, and also an amount of lands which had been purchased to use in part for the construction of the canal, and in part for the utilizing of the water powers along the lines of water communication.

And from this claim of ownership and right they state as a sequence that the canal company was possessed of power to use the property as a whole to advance the interest of navigation *and for the benefit of water powers*, and do whatever could lawfully be done in manipulating the waters of the rivers and lakes, and to advance the interests of *both the water powers and of navigation.*

That it could and did draw water through the canal from the Wisconsin River into the Fox, and make the upper Fox navigable throughout the season of navigation, and thus acquired a right to use the water so drawn, for the purposes of *water power* through Lake Winnebago in the lower Fox.

That it could and did impound the water of the Wolf and upper Fox in Lake Winnebago and its connecting lakes, and use the water so impounded to maintain navigation and the *water powers.*

That the deed from the company to the United States was the result of an arbitration under the act of Congress heretofore cited, to fix the value of the line of water communication *preparatory to extending such line of water communication down the Wisconsin River to the Mississippi.*

That the arbitration fixed the total value, in gross, of all the property, real, personal, and mixed, of the company in use for maintaining the navigation at the sum of $1,048,070, and fixed the amount realized from the sale of public lands for the use of the improvement at $723,070, leaving a balance of $325,000 to be paid for all the property and franchises of the company.

That the arbitrators made further report, separately, viz:

That the water powers created by the dams and surplus water not required for purposes of navigation were worth $140,000, and the value

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of the personal property scheduled was fixed at $40,000, these latter sums to be deducted from the $325,000 in case the Government should decline to take the water powers and personal property.

That the Government did decline to take the water powers and the personal property, but paid for the remaining property covered by the arbitration the sum of $145,000 as the consideration for the deed hereinbefore stated.

The canal company, upon this statement of fact and law so made, states as the first premise leading to the conclusion upon which its present claim is based:

That it is plain from this statement that it was not intended that anything should be lost in this transaction by anyone, but that the United States should get the legal title to the whole line of water communication—canals, locks, dams, etc., subject to an easement therein in favor of the canal company for maintaining and protecting the water powers as fully as a prudent owner of both the navigation and the water powers would preserve and protect the powers, subject always to the prior right of navigation (which it concedes belongs to the Government).

That it was also intended that the canal company should retain the personal property reserved by the deed, and the water powers created by the dams, locks, and canals, *and the right of preservation and protection thereof, and the lots, pieces, and parcels of land necessary to the enjoyment thereof.*

In support of this declaration of what was intended, the canal company states as an argument that—

> nothing was abated from the full value of the water powers when that value was deducted from the total value of the work of improvement, for any injury that might happen to them, for any lack of safe and ample protection and preservation of the dam by the United States, and no abatement of value, or quantity, or care and preservation of the water power was suggested—

and insists that the full right of preservation and protection appurtenant to the water power was reserved by the deed.

As a deduction from the premises laid down by them, the canal company contends:

> That the Government is bound, as of its own contract, to keep up and maintain the dams, locks, and canals conveyed to it by the canal company, in order to protect and preserve the water powers.

In support of this contention the canal company alleges that the terms of the deed executed by it and accepted by the Government come within the rule—

> That a party to a contract which provides that something shall be done by him is bound by that contract to do the thing the contract provides that he shall do if he accepts the contract.

The canal company, in avoidance of any claim of obscurity that may be made against the language of the deed, from which it could be argued that it does not appear what the rights of preservation and protection appurtenant to water powers are, contends—

> that the language, if not exact, must mean something, and that meaning must be gathered from the language and subject-matter of the deed—

and, proceeding, insists that the language of the deed contained in what is called the "exception" or "reservation clauses" of the deed, and stated therein as follows:

> Second. Also, all that part of the franchise of said company, viz, the water powers created by the dams, and by the use of surplus water not required for the pur-

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poses of navigation, with the rights of protection and preservation appurtenant thereto, and the lots, pieces, or parcels of land necessary to the enjoyment of the same, and those acquired with reference to the same—

Amounts to a "reservation" as distinguished from an "exception," and that without such reservation the water powers reserved would have been held at the pleasure of the War Department.

The contention of the canal company proceeds upon this last claim of "reservation," as distinguished from "exception," and grows up under it a new estate, whereby there was granted "an easement of the water powers in the property conveyed, with the right of the preservation and protection of the water powers moving from the United States to the canal company," citing, in support of the contention, Fisher *v.* Lack (76 Wis., 317); Perkins *v.* Stockwell (131 Mass., 529), and proceeds, arguendo, to claim that the words "appurtenant thereto" must mean "that the company should have the right as against the United States to have the water powers created by the dams protected and preserved by the United States for the benefit of the company," and further draws the conclusion that since it is conceded "that the principal object to be obtained by the work of improvement being a public benefit, hence the burden of maintaining the work, as well as the cost of constructing it, *it, as well as the incidental water powers, should be upon the public*" upon the authority of Kaukauna Co., appellant, *v.* G. B. and M. Canal Co., respondent (142 U. S., 254, 278), and concludes this special contention with the argument that if the words "with the rights of protection and preservation appurtenant thereto" do not mean what the company claims for them, they must of necessity have no signification.

The canal company also makes a further contention on the construction of the deed:

That the Government, by the force of the implied covenants made by the acceptance of the deed, has not the option to abandon the dams and works of improvement, or permit them to go in bad repair; but, on the contrary, that the full duty of the Government requires a maintenance of the dams at the expense of the Government in the future, irrespective of the continuance of the use of the waters of the Fox River for the purposes of navigation and commerce.

And contends that if their construction of the deed is resisted that the United States ought to bring action against the canal company for a construction of the deed, since the canal company has no legal right to bring an action against the United States for the same purpose.

Lastly, the canal company closes its statement of points of contention by admitting that the ownership of the canal and lock at the Telulah water power at the lower dam at Appleton, being a part of the improvement for the navigation of the Fox River, is really in the canal company, and that it has not been conveyed to the United States simply to compel a suit to be brought in which such deed, given by the company, could receive a judicial construction.

The Neenah and Menasha Water Power Company, under date of May 19, 1897, acknowledge the receipt of notice by me to them, hereinbefore stated, but no further appearance or action has been taken by them.

For the purposes of this report it will be assumed that they claim to hold their dam across the north branch of the Fox leading out of Lake Winnebago, adversely to the United States, under a patent of certain lands, wing dam, sawmills, etc., granted by the Government to Harrison Reed on the 18th day of July, 1845.

There is another speck of war at the canal at Portage, leading from the Wisconsin River into the Fox River, where settlers have extended their holdings on either side of the canal down to the canal itself, and

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in some instances use the canal to aid as an outlet for sewage pipes or drains from the city of Portage. There the rights of the Government to go even upon the banks of the canal to repair and improve are absolutely disputed, and laborers who have been employed for the work have been successfully prosecuted as trespassers for so entering.

There may be, in addition, other disputed questions arising with the United States along the line of works, arising at points where no title was acquired by the canal company or its predecessors of the land taken and used by them in the construction and improvement of navigation, but in no case known or presented to me is there a denial of the right of the United States to maintain the dams, canals, and locks as now.

The power to take and use is admitted. Congress by several acts of appropriation has paid for, and the Government through the office of the Attorney-General also settled and paid for large claims for damages for flowage to the owners of the land adjoining Lake Winnebago and its tributaries for supposed damages done to their real estate from flowage occasioned by the erection and maintenance of dams at the outlet of Lake Winnebago, built in aid of navigation, and which were assumed by the Government at the time of its purchase from the canal company.

There have been since such payments and settlement occasional outcropping of other claims and grievances against the United States for damages, real or supposed, but nothing serious, most of which have died away only to return again at some future time largely aggravated in statement and increased in amount of claim.

This is a condition universally concomitant with all works of improvement undertaken by the United States for the benefit of its people and their commerce, wherever the shadow of a prospect seems to be cast upon which can be hung even a slight hope of personal gain.

It can not be avoided; it is a weakness of human nature. But it must be understood that, in all cases where rights of riparian owners are supposed to come in conflict with the power of Government to take and use in aid of navigation for commercial purposes, there will be such questions continually arising, as new circumstances and changed condition of things present themselves, and they, too, can not now be anticipated.

The questions arising under the act submitted to me for consideration and report seem to require, for sake of perspicuity, that they shall be considered in the following order:

I. The rights of the United States in their broadest sense under the Constitution in the navigable waters within its domain.

II. What are the rights of the United States in the southern outlet of the Fox River, leading from Lake Winnebago, known as the "Neenah Channel?"

III. What are the rights of the United States under its deed of purchase from the Green Bay and Mississippi Canal Company?

I beg leave to submit under these three headings, after careful investigation, inquiry, and study, the following conclusions:

The power of the General Government, conferred upon it by the Constitution, is supreme over navigable waters within the States, so as to preserve their free navigation, when Congress shall see fit to exercise the same; but it is exclusive of State authority only, when the subjects upon which it is exerted are national in their character, and admit and require uniformity of regulation, affecting alike all the States; and when the subjects are local in their nature or operation, or constitute mere aids to commerce, the States may provide for their regulation and management until Congress intervenes and supersedes their action. (Cardwell *v.* Bridge Co., 113 U. S., 205.)

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The clauses of the Constitution under which this power is maintained and upheld in the United States read as follows:

> The Congress shall have power * * * to regulate commerce with foreign nations, and among the several States, and with the Indian tribes, * * * to make all laws which shall be necessary and proper for carrying into execution the foregoing powers. (Article I, section 8.)
>
> This Constitution and the laws which shall be made in pursuance thereof, * * * shall be the supreme law of the land, and the judges in every State shall be bo thereby, anything in the constitution or laws of any State to the contrary notwithstanding. (Article VI.) (Gilman *v.* Philadelphia, 3 Wallace, 713.)

The rule as laid down in this case now goes unchallenged, and in the application of this rule, wherever Congress by legislation has put in motion and authorized the execution of this power, then in such case the rule is settled, that the Government is in no case responsible for damages sustained by any citizen in the execution of the power, when such damages are not direct but are consequential.

The language used by the Supreme Court of the United States, speaking through Mr. Justice Strong, on the liability of the Government under such circumstances to pay damages, is as follows:

> Acts done in the proper exercise of Governmental powers, and not directly encroaching upon private property, though their consequences may impair its use, are universally held not to be a taking, within the meaning of the constitutional provision. They do not entitle the owner of such property to compensation from the State, or its agents, or give him any right of action.
>
> This is supported by an immense weight of authority. Those who are curious to see the decisions will find them collected in *Cooley on Constitutional Limitations, page 542, and notes.*
>
> The extremest qualifications of the doctrine are to be found, perhaps, in Pompelli *v.* Green Bay Company (13 Wallace, 166), and in Eaton *v.* Boston, Concord, etc., Railroad (51 N. H., 504).
>
> In those cases it was held that a *permanent* flooding of private property may be regarded as a taking. In those cases there was a physical invasion of the real estate of the private owner and a practical ouster of his possession. (Transportation Co. *v.* Chicago, 99 U. S., 635.)

But there grows out of a right conferred in navigable waters by a State, where Congress has failed to assume to exercise its constitutional power, another and distinct rule of damages, when at a later period and after investment upon the faith and credit of State authority by the citizen, the United States shall resume its supreme power and control over such navigable water, and in the exercise of that power in its judgment and discretion, shall condemn, destroy, or convert the property of the citizen therein invested, under such State authority.

That rule of damages, after a most exhaustive discussion, is clearly maintained and approved by the Supreme Court of the United States to be—

> That wherever the citizen shall rightfully place or invest his property, whether in navigable water or elsewhere, and it shall be subsequently taken, destroyed, or appropriated by the United States, that in such case, under the fifth amendment of the Constitution of the United States, he shall be entitled to receive compensation therefor.

Such a case being, in the language of the court, within the prohibition of that amendment.

> Nor shall private property be taken for public use without just compensation.

The latest declaration of law upon this subject is in the following language:

> All navigable waters are under the control of the United States for the purpose of regulating and improving navigation, and, although the title to the shore and submerged soil is in the various States and individual owners under them, it is always subject to servitude in respect to navigation created in favor of the Federal Government by the Constitution. (Gibson *v.* U. S., 166 U. S. Reports, p. 269.)

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Having thus stated broadly the rule governing the right of the United States to take and use property for public use, there arises another question which becomes quite important in view of one of the claims made by the Green Bay and Mississippi Canal Company. The question is, Can the United States abandon the public use for navigation, when it shall cease to be practicable, and remain liable to support and maintain the public work for the sole use and benefit of a private individual or corporation?

Touching this subject and the question involved, the Supreme Court of the United States, in a case in which the Green Bay and Mississippi Canal Company were parties, touching the water powers created by the improvement now under consideration, declare:

> The improvement of the navigation of a river is a public purpose, and the sequestration or appropriation of the land or other property, therefore, for such purpose, is doubtless a proper exercise of the authority of the State under its power of eminent domain. Upon the other hand, it is probably true that it is beyond the competency of the State to appropriate to itself the property of individuals for the sole purpose of creating a water power to be leased for manufacturing purposes. This would be a case of taking, not a constitutional exercise of right of eminent domain. (Kaukauna Company *v.* G. B. and M. Canal, 142 U. S., pp. 272, 273 of Opinion.)

The application to the claim made by the canal company, and adverse to it, is still stronger when considered in connection with that clause in the Constitution which declares:

> The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States, respectively, or to the people.

Again, the Supreme Court, in the case last cited, refer to the case of Little Miami Elevator Company *v.* Cincinnati (30 Ohio St., 629), seemingly with approval, and say:

> It was doubted whether the State could, after abandoning the canal as a public improvement, still reserve to itself the right to keep up a water power solely for private use and as a source of revenue. "By so doing," said the court, "the water power would cease to be an incident to public use, and the State would be engaged in the private enterprise of keeping up and renting water power after it ceased to act as a government in keeping up the public use."

A further reference is made to the case and to an earlier case in the Supreme Court of the United States, wherein the court say:

> The use of the water for hydraulic purposes is but an incident to the principal object for which the canal was built, to wit, navigation. The large expenditures of the State were to furnish, not water power, but a navigable highway for the transportation of persons and property. The authority of the board of public works to contract in respect to power was expressly confined to such water as remained after the wants of navigation had been supplied, and it never could have been intended in this way to impose on the State an obligation to keep up the canal, no matter what the cost, for the sole purpose of meeting the requirement of its water leases. There was certainly no duty resting on the State to maintain the canal for navigation any longer than the public necessities seemed to require. When it was no longer needed it might be abandoned, and if abandoned the water might be withdrawn altogether. Provision was made for resuming the water and stopping the supply if the canal was kept up for navigation, but no such provision was necessary in respect to the abandonment of the whole work, because the right to abandon followed necessarily from the right to build. (Fox *v.* Cincinnati, 104 U. S., p. 783.)

And again, in the same opinion, the court declare:

> The true distinction seems to be between cases where the dam is erected for the express or apparent purpose of obtaining a water power to lease to private individuals, or where in building a dam for a public improvement a wholly unnecessary excess of water is created, and cases where the surplus is a mere incident to the public improvement and a reasonable provision for securing an adequate supply of water at all times for such improvement. (142 U. S., supra, p. 275.)

The improvement of the Fox River in the State of Wisconsin by the General Government, either by itself or by or through its trustees, was

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an attempt at the improvement of a navigable river, and so falls within that class of rivers over which the supreme supervision of the United States has been upheld and maintained under the authorities above cited.

Under the articles of the compact in the ordinance of 1787 between the United States and those States ceding public lands owned by them to it, which included Virginia, then owning the territory out of which, among others, the States of Michigan and Wisconsin have since been erected, it was, among other things, provided in Article IV:

> The navigable waters leading into said Mississippi and St. Lawrence, and the carrying places between the same, shall be common highways, and forever free as well to the inhabitants of said territory as to the citizens of the United States and those of any other States that may be admitted into the confederacy without any tax, impost, or duty therefor.

The State of Wisconsin, in its constitution, in express language recognizes the validity of this article of the compact, and substantially reiterates it in its constitution by providing that—

> The river Mississippi and the navigable waters leading into the Mississippi and the St. Lawrence, and the carrying places between the same, shall be common highways, and forever free as well to the inhabitants of the State as to the citizens of the United States without any tax, impost, or duty therefor.

Whatever may be said about the effect which the adoption of the Constitution of the United States had upon the ordinance of 1787, Congress has by subsequent acts so far recognized and adopted the ordinance of 1787 on this subject as to give it the force of existing law. (DePue *v.* Wabash & Erie Canal, 5 Ind., 8.)

The supreme court of Wisconsin, through its distinguished chief justice, in 1875 uses the following language:

> Navigable waters leading into the Mississippi and St. Lawrence constitute a peculiar class of highways, which can not be considered local for jurisdiction. They are not merely highways; they are a trust from the Federal Government to the State, accepted by the State, which the State is bound to keep as common highways forever, free to the people of the State and of the United States. (Attorney-General *v.* City of Eau Claire, 37 Wis., p. 446.)

And Congress, in 1846, to take effect on the admission of Wisconsin as a State into the Union, passed an act granting a quantity of land to the State "for the purpose of improving the navigation of the Fox and Wisconsin rivers in the Territory of Wisconsin, and of constructing the canal to unite the said rivers at or near the portage," wherein, among other things, it was provided that—

> Said rivers when improved, and the said canal when finished, shall be and forever remain a public highway for the use of the Government of the United States, free from any toll or other charge whatever, for the transportation of mails, or for any property of the United States, or persons in their service, passing upon or along the same.

Which grant was accepted by the State of Wisconsin, and by it and under its authority and legislation a company was incorporated by an act approved July 6, 1853, for the improvement of the Fox and Wisconsin rivers.

Afterwards a question arose in admiralty whether steamboats navigating the Fox River were subject to the admiralty jurisdiction of the United States, and the point made, and upon which the case turned, was the question whether the Fox River was within the classification of navigable rivers or waters.

This question was decided affirming the navigability of the Fox River and the correctness of its classification as a navigable water within the jurisdiction and control of the United States (The Montello, 20 Wallace, 430); and the test therein made of the point constituting

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"navigability" within the meaning of the law has been universally approved from its utterance in that case until the present time.

The discussion and report upon the general power of the United States over navigable rivers within its borders, which have become or may become avenues of commerce between the States, will be concluded by the statement of three additional propositions:

I. That all purchases from and grants made by the United States, under which riparian rights are or may be claimed in such navigable rivers, can only properly be construed as having been made and received in view of the then existing law; that is, subject to the rights of the Government to improve the navigation in such streams under the authority and with the restriction only as hereinbefore stated. (See Gibson *v.* United States, cited supra.)

II. The United States, in asserting its rights in the improvement of navigable rivers, is not barred by any statute of limitations, unless Congress has clearly manifested its intention that it should be so barred. (United States *v.* Nashville, etc., Ry. Co., 118 U. S., 125.)

The reason of this rule is very happily and forcibly stated by Mr. Justice McLain, speaking for the court, in Lindsey et al *v.* The Lessee of Miller (6 Peter's Reports, on p. 672):

> It is a well-settled principle that the statute of limitations does not run against a State. If a contrary rule were sanctioned it would only be necessary for intruders upon the public lands to maintain their possessions until the statute of limitations shall run, and then they would become invested with the title against the Government and all persons claiming under it. In this way the public domain would soon be appropriated by adventurers. Indeed, it would be utterly impracticable, by the use of any power within the reach of the Government, to prevent this result. It is only necessary, therefore, to state the case in order to show the wisdom and propriety of the rule that the statute never operates against the Government.

III. The unquestionable power to improve the navigable waters of the United States is vested in the Government, and it is the exclusive judge of the most expedient mode of exercising it.

There is a case in the Supreme Court of the United States arising upon the following facts:

> The Savannah River, where it flows past the city of Savannah, is divided into two channels by Hutchinsons Island, which extends above and below the city, with a length of about 6 miles and a width, where widest, of 1 mile or more. Of these channels the more northerly is known as "Back River," while that which passes immediately by the city of Savannah is called "Front River." The improvement consists in the construction of a crib dam, known at a point as the "Cross Tides," for the purpose, by diverting a sufficient quantity of water passing through the Back River into the Front River channel, of securing to the city a depth of 15 feet at low water.

The remedy sought was by bill in equity for an injunction restraining the Secretary of War and the Chief of the Corps of Engineers of the United States Army, and their agents and subordinates, from obstructing or interrupting the navigation of the Savannah River in violation of a contract entered into between the States of South Carolina and Georgia on the 24th day of April, 1787.

Article II of the compact, upon which the complainant rests its equity, among other things declares that the—

> water wherein the construction of the Government was being made should be henceforth equally free to the citizens of both States, and exempt from all duties, tolls, hindrance, interruption, or molestation whatsoever attempted to be enforced by one State on the citizens of the other.

The court say:

> After the treaty between the two States was made both the parties to it became members of the United States. Both adopted the Federal Constitution, and thereby

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joined in delegating to the General Government the right to regulate commerce with foreign nations and among the several States. Whatever, therefore, may have been their rights in the navigation of the Savannah River before they entered the Union, either as between themselves or against others, they both agreed that Congress might thereafter do everything, which is within the power thus delegated. That power to regulate interstate commerce and commerce with foreign nations, conferred upon Congress by the Constitution, extends to the control of navigable rivers between States—rivers that are accessible from other States, at least to the extent of improving their navigability—has not been questioned during the argument, nor could it be with any show of reason. From an early period in the history of the Government it has been so understood and determined.

Prior to the adoption of the Federal Constitution the States of South Carolina and Georgia together had complete dominion over the navigation of the Savannah River. By mutual agreement they might have regulated it as they pleased. It was in their power to prescribe not merely on what conditions commerce might be conducted upon the stream, but also how the river might be navigated, and whether it might be navigated at all. They could have determined that all vessels passing up and down the stream should pursue a defined course and that they should pass along one channel rather than another, where there were two. They had plenary authority to make improvements in the bed of the river to divert the water from one channel to another and to plant obstructions therein at will. This will not be denied; *but the power to "regulate commerce" conferred by the Constitution upon Congress is that which previously existed in the States.* * * * For these purposes Congress possesses all the powers which existed in the States before the adoption of the National Constitution and which have always existed in the Parliament of England. [Citing Gilman *v.* Philadelphia, 3 Wallace, 724, cited supra.] Such has uniformly been the construction given to that clause of the Constitution which confers upon Congress the power to regulate commerce. (S. Carolina *v.* Georgia et al, 93 U. S., pp. 9, 10, et. seq.)

Proposition II now presents itself in order:

What are the rights of the United States in the southern outlet of Fox River, leading from Lake Winnebago, known as the "Neenah Channel?"

The consideration of this question is more appropriately considered here separate and distinct from all other questions arising, and upon which I am called to report, for the reason that the North Branch of the Fox River, or the Neenah Channel, so called, with its dam and improvements, is not covered by the deed from the Green Bay and Mississippi Canal Company, which will be a later subject for consideration.

The Fox River, at its point of debouche from Lake Winnebago, separates into two channels, each leading northerly, but between the two there is an island of small area known as "Doty Island." The one upon the northern side of the island was called the "Menasha outlet or channel," and that upon the southern side was known as the "Neenah Channel or outlet," each meeting and joining in a little lake below the island known as "Little Butte des Mortes."

The situation will be clearly seen by reference to the descriptive map of the Fox River, accompanying this report.

The greater volume of water in its natural state always flowed through the northern or Menasha Channel.

The original survey, made by Captain Cram, of the United States Army, in 1839, and which is in the possession of the Department, but of which I have no copy, will show clearly the condition of the lower Fox River, and especially of the two channels leading out of Lake Winnebago, in their natural condition at that time.

Russell's survey, in 1874, of the two channels, Neenah and Menasha, which is in the possession of the Department, but of which I have no copy before me, will show their condition at the date of such survey.

The south channel was the one selected or designated by Captain Cram as the most available for the improvement contemplated in the river, but there does not appear to have been any action taken toward

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utilizing such channel for such purpose, except as appears from an act of the Territorial legislature of Wisconsin, February 8, 1847, which granted to Harvey Jones, Loyal H. Jones, Harrison Reed, and Charles Doty authority to construct a dam across the Fox River at Neenah, and to make use of the water power of said river for hydraulic purposes. The dam was to contain a suitable lock, 120 feet long, 24 feet wide, and the proprietors were to pass all water craft through the lake free of charge. The advertisement for proposals by the board of public works, under date of October 22, 1849, for the improvement of both outlets, resulted in the adoption of the Menasha outlet.

Harvey Jones was the riparian owner on the south shore of the outlet, and Charles Doty was the riparian owner on the north shore. Doty quitclaimed, under date of August 8, 1846, all riparian rights of water power to Jones. Jones built a dam with a lock, but whether in compliance with the act of the legislature or not is exceedingly questionable, and whether it was built until after the act authorizing him to build it was repealed by an act of the same legislature, approved March 10, 1848, can not clearly be ascertained.

The writer remembers distinctly of hearing much discussion in 1850, pending the settlement of the Harvey Jones estate—he having died—in which certain claims and rights growing out of the construction of what was said to be a brush dam across the Neenah Channel was involved. He also remembers very distinctly that so early as that time the line of navigation used passed on the north side of Doty Island and not through the Neenah Channel, and the reason assigned was the relative depth of water between the two sides, the Menasha Channel having water to take vessels of greater draft.

The effect of the repeal of the act authorizing Jones and his associates to build a dam, with the conditions annexed, as stated in the act, makes no question of any weight to be raised against the occupancy of the Neenah Channel by the United States without compensation, because the claim for compensation for damages sustained, if any could obtain, was against the territory creating the damage, and the lapse of almost half a century since the damage, if any, accrued, will bar the making of any claim therefor now, after so many years, the presumption being conclusive that there was no damage suffered, or that it was fully paid and discharged.

But it is not necessary to consider the question of compensation if the dam were built within the life of the law, for the reason that by the terms of the act conferring the power to build such dam it was provided—

> That said dam shall not raise the water in Lake Winnebago above its ordinary level.

This clause and its effect upon the legality of the act, and of any acts done under it, have been passed upon directly by the supreme court of the State of Wisconsin, holding that the act was inoperative and could confer no power to construct a dam under its provisions. (Arimond *v.* G. B. and M. Canal Co., 31 Wis., 316.)

The crude dam itself, with its lock, has long since ceased to exist, and the site of the lock is now occupied by railway tracks.

The map and survey of Captain Cram, to which reference has been made, shows a much older structure in the Neenah outlet, being a wing dam and race, extending partially into the channel, which was a structure for the benefit of the Menominee tribe of Indians, who occupied the lands on either side of the Fox River at that time, and were wards of the Government under a treaty made with them in the year 1831,

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stipulating that the United States would erect a gristmill and sawmill on the Fox River for their benefit.

It appears, also, that in September of 1836, by another treaty with the said Menominee tribe of Indians, the United States were released from the provisions of the treaty of 1831, and therein the said tribe did relinquish all their right under said treaty.

The United States, by a conveyance dated July 18, 1846, executed by William L. Marcy, Secretary of War, under authority thereto conferred upon him by act of Congress, made a conveyance to one Harrison Reed—

In consideration of the sum of $4,760, the following tracts or parcels of land, situate in the Territory aforesaid, at or near the Winnebago Rapids at the outlet of Winnebago Lake, heretofore known as the "Menominee Reservation," to wit:

Lot number one (1), section twenty-one (21), and the northwest quarter (¼) of the northwest quarter (¼) of said section; fractional section twenty-two (22), and that part of fractional section twenty-six (26) which contains twenty-two (22) acres and $\frac{44}{100}$ of an acre; the north half (½) of fractional section twenty-seven (27), lot number four (4) of fractional section twenty-seven (27), the northwest quarter (¼) of the southeast quarter (¼) of said section, and the north half (½) of the southwest quarter (¼) of said section, all in township twenty (20), range seventeen (17) east of the 4th meridian, containing five hundred and sixty-two (562) acres and $\frac{44}{100}$ of an acre, be the same more or less.

Together with all and singular the hereditaments, buildings, and improvements thereon, erected and belonging or in anywise appertaining, and all the right, title, interest, and estate of the United States in and to the same.

To have and to hold the said tracts or parcels of land and the herein granted premises unto the said Harrison Reed, his heirs, executors, administrators, or assigns, forever, freely and fully in fee simple, as the United States holds and possesses the same.

The Neenah and Menasha Water Power Company claim through mesne conveyances from the said Harrison Reed, through this deed, to erect, keep, and maintain a dam for hydraulic purposes, at their own pleasure, and subject to their own exclusive control, adverse to any right of the United States, except such right as may be acquired by condemnation and payment; and claim further—

That relying upon their rights under such conveyance to use the full, original, natural flow of water through said south outlet, and at a head equal to that existing and in use at the time the United States granted the same, have expended not less than one million of dollars in dams, canals, locks, mills, machinery, and appurtenances.

This claim so presented is of modern date, and, from the report of the Government engineers in charge of the Fox and Wisconsin improvement, it appears that the proprietors have at all times operated their dam in accordance with the necessities of navigation, recognizing the right of direction and control by the General Government up to a very late period.

It is also indisputable that the Government, in the progress of its work of improving the navigation of the Fox River, has removed obstructions at the mouth of said lake and at the head of said Neenah outlet, of extended dimensions, and increased the flow of water in such outlet to such an extent as to give a seeming foundation for rival owners of water power upon the northern channel to assert that the same was done for the benefit of the proprietors of said Neenah dam and not called for by the wants of navigation, but, on the contrary, were prejudicial to the necessities of navigation.

Such work and improvement were done at the request of the proprietors of such dam, made to the United States as the sovereign power controlling the said channel.

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It appears also that Harrison Reed, under whom the said proprietors now claim adverse to the Government, was one of the parties authorized to construct a dam across said southern outlet by the act of the Territorial legislature of 1847. It does not seem quite probable that had the said Reed owned at that time, in his own right, by deed from the Government, dated July 18, 1846, a dam for hydraulic purposes across the southern inlet of the Fox River, known as the "Neenah Channel," that he would have made himself a party to an application to the legislature of the Territory of Wisconsin, in the winter of 1846–47, for authority to construct, erect, and maintain a dam. It seems to me that this act of his, on this authority so conferred upon and accepted by him, is entirely repugnant to the idea that he was then the owner and possessor of a dam across such outlet, and this conclusion partakes of absolute verity when, by reference to the act authorizing Harrison Reed, among others, to construct a dam across the southern outlet of the Fox River, February 8, 1847, provides as the point of location the same identical descriptions of land contained in his deed from the Government, under which the claim of said proprietors is now made.

The deed from the Government to Harrison Reed granted to and created in him just the same riparian rights as the patent of any other land on the Fox River to a purchaser conveyed—all subject to a servitude in the public.

Upon these facts and the action of the parties, and upon the information derived from the map of Captain Cram, above referred to, and from the action of the proprietors of the dam across the southern outlet, I can not escape the conclusion, and therefore report, that in my judgment the dam now maintained across such outlet by the Neenah and Menasha Water Power Company is without authority, and that it was originally built and has ever been maintained without authority, and that the United States have authority to cause its removal, if it shall deem it proper to do so, or may divert the water from that channel to the Menasha Channel to such a degree that it may be unavailable as a water power without any compensation whatever.

It may be admitted that if the old Neenah wing dam existed at the time of the appropriation of the channel by the Government, that there might be some question whether or not it, having been built by the Government, did not entitle the riparian owner to compensation for its destruction if it was of any value. But that right can not possibly extend to a right to demand payment for a dam costing, as it is alleged, $1,000,000, or any other dam for hydraulic purposes extending from shore to shore across the outlet.

There are no other questions arising over this outlet from Lake Winnebago, and this brings me to the consideration of Proposition III in my classification:

What are the rights of the United States under its deed of purchase from the Green Bay and Mississippi Canal Company?

The consideration of this proposition opens wide the door for the history of the Fox River and its improvement. Its history is replete with interest and reminiscence.

The first trace that comes to us of its use by a white man dates back to 1620, and from that time down until French domination ceased in Canada it was one of the great highways connecting the isolated settlement and missions of France with Montreal and Quebec. Its travelers were the fiercest savages of the Northwest and the Canadian voyageur and courier despois, little less savage than the former; the methods of transportation, with the canoe and the bateau.

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The first use of this water by the Government that has come to my knowledge was the transshipment of the Third United States Infantry in a fleet of 35 boats from Green Bay to St. Louis in 1826.

The first legislation to which my attention has been called was an act of the Territory of Michigan to incorporate Summit Portage Canal and Road Company, approved October 23, 1829.

The improvement and the glorious results that were to be attendant upon it were the life dream of the old settler and speculator along its banks. Before the year 1850 the little birds of promise sang in the ear of the writer of its future success, and of the untold wealth and prosperity that was to attend all who lived upon or invested along its borders. Where Neenah and Menasha are now situate was to be the great entrepot of commerce. From the mouth of the river to its departure from Lake Winnebago was largely a platted city, and at the foot of Lake Winnebago was laid out a large city, I think known by the name of "Webster City." It was thought that the improvement of the river and its connection with the Wisconsin would make an interior waterway connecting the Atlantic and the Gulf of Mexico for the passage of the largest ships for freight. The flag of every nation was expected to be seen floating along the interior waters and passing out through the Gulf of the St. Lawrence into the Atlantic Ocean. The effect upon the trade of the Atlantic Seaboard was to be largely disastrous, and correspondingly beneficial to the country adjacent to the inner life.

An old gentleman whose soul was wrought up in this magnificent national work said to the writer in the fall of 1850 that it was a great pity the dam at Depere had been permitted to be built so close down to the mouth of the river, as the distance, which is some 4 miles and more, would not leave sufficient room for a harbor for vessels passing to and fro.

The glory of the Fox and Wisconsin River improvement may then be said to have been in apogee. From that time until the present it has steadily diminished in glory, until it would seem that it had now reached its perigee.

There were many factors which brought about this result that were entirely overlooked and unthought of by the dreamers of the first half of the Nineteenth century.

It did not seem possible that the great water way apparently designed by nature to connect the Great Lakes and the Gulf would be supplanted by other means of communication more rapid and satisfactory.

It did not seem that the great territory of the Northwest would be settled from the south instead of from the north.

It did not seem that the great city of Chicago and the minor cities upon the shores of Lake Michigan on either side would spring up, and that the great channel of trade and commerce from the East by water would be upon established lines from Eastern ports to those ports upon the lakes instead of to Green Bay.

It did not seem that what we know now to be the laws of commerce and trade would prevent shippers, freighters, passengers, and vessel owners from leaving the great thoroughfare to dodge in upon side routes for the benefit of a trade of what has proven to be nothing but a cul-de-sac. Every section of the West so expected to be supplied through the avenue of the Fox River is reached by railway communication, and there is nothing left except here and there a sporadic barge loaded with salt, coal, and lumber to be distributed to points along the Fox; the whole aggregated together making but a diminutive drop in the great ocean of trade.

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The arbitrators, upon whose report the Government made purchase of this improvement, report of it:

If considered as a pecuniary investment, in its present condition the property is of little actual value to the canal company or to any other party. It pays but little revenue. Its revenues do not, in fact, pay expenses and repairs. While it may be of very great value to the State, it has for many years been a source of expense to its proprietors. *As a water channel, it has and can have, no value,* therefore, except in the future, by becoming a part of a great through water route between the Mississippi River and Lake Michigan—a route, if once completed, of incalculable value to the people of all the States, east and west. (See Report of Arbitrators to Secretary of War, dated November 15, 1871.)

The navigation of the Fox River is of but little value until the Wisconsin River is improved, and the first step will be to improve the latter stream so as to make the Fox River available for through navigation. (See report of Major Houston, engineer in charge, dated February 26, 1872.)

In connection with this statement of the single point upon which any value can attach to this improvement, your attention is called to the fact that the improvement of the Wisconsin River was abandoned in 1886 by the United States. (See report of Capt. Geo. A. Zinn, engineer in charge, Milwaukee, December 5, 1896.)

Hence it would seem to follow that the last vestige of value remaining, in prospective, to the Fox River improvement, as a national work, disappeared by the abandonment of the improvement of the Wisconsin River by the United States in 1886.

That the River Wisconsin was impracticable for any purpose of improvement was known years before by all familiar with the river and its channels and courses, and the light sand through which it wended its way, constantly changing its winding course to the Mississippi. It may be used as a feeder to the waters of the Little Fox, but in seasons of drouth and low water it is absolutely valueless for any such purpose; and there is no appreciable commerce on the Little Fox to be benefited by such feeding.

It is submitted, most respectfully, that while the work of the improvement is a monument to the science of engineering, there is nothing remaining about it which renders its continued maintenance and preservation of any value worthy of consideration as an aid to national or local commerce. The endeavor to keep it up and to force results is a struggle of crude means and methods of the early years of the Nineteenth century against the advancement of mechanics and science and art and of their governing laws of the last years of the same century. There can be no question as to the result and which must give way.

The waters of the Fox River, leading from Lake Winnebago to Green Bay, are of immense value for use by private enterprise. There is, and there will always be, a tendency to friction between the riparian owner using the water power and the dam owner claiming to hold and distribute water for purposes of navigation, because the maintenance for purposes of navigation has long since substantially ceased.

But taking up seriatim the legislation by the United States in reference to this work, it will be found that the Congress of the United States, by act approved August 8, 1846—

Granted to the State of Wisconsin, on the admission of such State into the Union, for the purpose of improving the navigation of the Fox and Wisconsin rivers in the Territory of Wisconsin and of constructing the canal to unite the said rivers at or near the portage, a quantity of land equal to one-half of three sections in width on each side of said Fox River and the lakes through which it passes from its mouth to the point where the portage canal shall enter the same, and on each side of said canal from one stream to the other, reserving the alternate sections to the United States, to be selected under the direction of the governor of said State, and such selection to be approved by the President of the United States.

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And the State of Wisconsin, by an act of its legislature approved June 29, 1848, accepted such grant.

And thereafter, on the 8th day of August, 1848, the State, by its legislature, passed "An act to provide for the improvement of the Fox and Wisconsin rivers, and connecting the same by canal, the work to be done under the direction and control of a board of public works."

The act defines the powers and duties of the board of public works, and appoints and creates a land office for the sale and disposition of the lands granted, and provides for the application of the moneys derived therefrom to the completion of the work.

Section 15 of the act reads as follows:

> In the construction of such improvements the said board shall have power to enter or to take possession of and use all lands, waters, and materials the appropriation of which for the use of such works of improvement shall in their judgment be necessary.

And sections 17, 18, 19, and 20 provide for the ascertainment of damages by the owner sustained by the taking of the land, and provides a means for the payment thereof.

This is a material provision, because under it, as will be seen at a later period of the report, much of the title to the lands taken and conveyed to the United States may rest.

The act of Congress granting the land was amended March 2, 1849, so as to save and preserve such titles and land entries as had been made in the Green Bay land district on the odd-numbered sections of the Fox and Wisconsin rivers.

The act providing for the board of public works was amended from time to time to meet the exigencies of the situation as they arose.

The State soon wearied of the work or found itself incompetent successfully to prosecute it, and by act of the legislature approved March 11, 1851, the State of Wisconsin authorized its governor to enter into a contract with Morgan L. Martin for the improvement of the Fox River between Lake Winnebago and Green Bay. The details of this contract are immaterial to the questions under consideration.

In 1852 the legislature of Wisconsin passed an act to provide for the completion of the improvement of the Fox and Wisconsin rivers, which, in substance, made provisions for bringing the lands granted by the General Government into market and for their sale upon terms therein provided, and application of the money to the construction of the work, and from this until July 6, 1853, several minor acts were passed concerning the said improvement, which do not require consideration.

But the legislature, by an act entitled "An act to incorporate an association for the completion of the improvement of the Fox and Wisconsin rivers," approved July 6, 1853, made provision for the organization of a new company to complete this work, to be known as the "Fox and Wisconsin Improvement Company."

This was the company from which the Green Bay and Mississippi Canal Company derived its title, which it purported to convey to the Government.

The second paragraph of the act provides:

> The work of improvement contemplated by the act entitled "An act to provide for the improvement of the Fox and Wisconsin rivers, and connecting the same by a canal," approved August 8, 1848, and by several acts supplementary thereto and amendatory thereof, and known as the "Fox and Wisconsin rivers improvement," together with all and singular the rights of way, dams, locks, canals, water power, and other appurtenances of said works, also the right of the State of demanding and receiving tolls and rents for the same, so far as the said State possesses or is authorized to grant the same, and all privileges of constructing said works and

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repairing the same, and all other rights and privileges belonging to the improvement, to the same extent and in the same manner that the State now holds or may exercise such rights by virtue of the acts above referred to in this connection, are hereby granted and surrendered by the State of Wisconsin to said Fox and Wisconsin Improvement Company. * * * This grant has attached to it divers and sundry provisos, which it is not material now to consider.

It is provided in a section of said act, among other things:

The lands granted by Congress in aid of said improvement, and remaining unsold, shall be, and are hereby, granted to the Fox and Wisconsin Improvement Company upon the following terms and conditions. * * * The Congress of the United States, by an act approved August 3, 1854, authorized the governor of the State of Wisconsin to make additional selections of lands to that which the State was entitled under the provision of the 8th of August, 1846, and establishing as the rule of quantity to be ascertained and selected the principles which governed the final adjustment of the grant to the State of Indiana for the Wabash and Erie Canal, under act of Congress approved May 9, 1848.

Afterwards the legislature of Wisconsin passed an act "To provide for the further improvement of the Fox River above Lake Winnebago," approved March 31, 1855, conferring authority upon the Fox and Wisconsin Improvement Company to improve the navigation of the Fox River above Lake Winnebago, according to the plan proposed by Captain Cram in his report to the Secretary of War Department of the United States, or in such other manner by dams, locks, and canals as will enable boats in not less than 3 feet of water to pass from Lake Winnebago to the Wisconsin River, and for that purpose and for discharging the obligations of said company, authorizing an increase of the capital stock of the company and assessments upon the same.

And further provide in section 2:

Whenever any of the canals, locks, or dams to be constructed along the said Fox River as contemplated in the first section of this act shall be located upon swamp and overflowed land, the property of the State, the said company is authorized to appropriate for the use of said canals, locks, and dams the lands upon which the same may be located, and a strip 150 feet in width on each side and along the whole length of said canals and locks; and all damages which the State might claim on account of such appropriation, or of flowage of the land belonging to the State, is hereby released and discharged.

The Congress of the United States again intervened by an explanatory resolution approved March 3, 1855, declaring the "intention of the act of Congress approved August 3, 1854, to be, and the same shall be, construed to give to Wisconsin in aid of the improvement of navigation of the Fox and Wisconsin rivers a quantity of land equal, mile for mile of its improvement, to that granted to Indiana under the provisions of the act of Congress approved May 9, 1848."

Afterwards, as new complications arose, the legislature of Wisconsin passed "An act to secure the enlargement and immediate completion of the improvement of the navigation of the Fox and Wisconsin rivers, and the payment of scrip and other evidences of indebtedness issued by the State on account of the same, and for the protection of settlers on the even sections," etc., approved October 3, 1856, providing for the conveyance by the company by deed of trust to three trustees, to be appointed as in said act directed, all the unsold lands granted to the State by the several acts and resolutions of Congress, to aid in the improvement of the Fox and Wisconsin rivers, and all the works of improvement constructed or to be constructed on said rivers, and all and singular the right of way, dams, locks, canals, water powers, and other appurtenances of said works, and all rights, privileges, and franchises belonging to said improvement, and all property of said company, of whatever name and description, for the uses, trusts, and purposes in such act named.

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And later passed an act entitled "An act to facilitate the sale of lands and other property of the Fox and Wisconsin Improvement Company, to provide for the proper application of the proceeds of such sale, *and to authorize the formation of a corporation by the purchasers,*" approved April 13, 1861.

Under this act, commissioners were appointed to determine, among other things, what sums shall be retained from the proceeds of the sale of lands and other property of the company for the completion of the works of improvement of said company, and authorizing a sale of the lands, and providing for the retention of such money as was necessary to complete the works.

This act authorized, generally, the organization of a new company, imposed certain duties and liabilities upon it, and granted it all the privileges held by the State and the Fox and Wisconsin Improvement Company, conveyed by the said company to the trustees, with full power to sell, convey, or otherwise dispose of the same.

Then it further provides for the disposition of the proceeds of sale.

It was under this act that the Green Bay and Mississippi Canal Company was organized and the sale made to them, they complying with all the terms and conditions required by this act.

. On November 27, 1856, the directors of the Fox and Wisconsin River Canal Company passed resolutions providing for the execution of the trust deed authorized by act hereinbefore referred to, for the purpose, as is recited, of raising funds for the construction, enlargement, and completion of the works of improvement, as required by the act of the legislature of the State of Wisconsin passed October 3, 1856, and accepted by the company.

On December 1, 1856, the trust deed was executed to Alexander Mitchell, of Milwaukee, in the State of Wisconsin, and Charles Butler, and Alexander Spalding, of the city of New York, in the State of New York, as trustees; Erastus Corning as president of the company, party of the first part, and the said trustees in person signing the same; and all attested by the secretary of the company, under its seal.

And afterwards, on the 12th day of December, 1856, Coles Bashford, as governor of Wisconsin, under the seal of the State, certified that the deed was executed within the time required by the act of October 3, 1856, and is in conformity to the act.

In July, 1862, the governor of Wisconsin appointed Moses M. Davis as trustee, vice Alexander Mitchell, resigned, which appointment was duly ratified.

On the 14th of September, 1863, the trustees under such trust deed filed their bill of complaint in the circuit court of Fond du Lac County, Wis., for the foreclosure of the trust deed and sale of all the property thereunder, wherein the Fox and Wisconsin Improvement Company and Isaac Seymour and Abraham B. Clark, as mortgagees, in a mortgage dated August 1, 1853, were made parties defendant. All parties to the bill answered, and submitted their rights to the court, and such proceedings were had in such court that on the 4th day of February, 1864, a judgment of foreclosure of the trust deed and mortgage and for sale was entered.

The proceedings in such case are very long and intricate, and are, in fact, not material, except as giving an outline of the history of the transition from one company to the other, it being conceded that in all respects the proceedings, including sale and confirmation and conveyance thereunder, were regular and approved and confirmed by a court of competent jurisdiction.

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On the 15th day of August, 1866, there was filed in the office of the secretary of state of Wisconsin, under chapter 289 of the laws of 1861, articles of association signed by Samuel Marsh, Erastus Corning, Horatio Seymour, John MaGee, Edward C. Delevan, William B. Ogden, John Catlin, Daniel Wells, jr., and Andrew G. Bunninger, certifying themselves to be the joint purchasers of the lands, water powers, works of improvement, and other property of the Fox and Wisconsin Improvement Company, at the sale thereof made at Appleton, in the State of Wisconsin, on the 1st and following days of February, in the year of our Lord 1866, by Charles Butler, Alexander Spalding, and Moses M. Davis, trustees of the Fox and Wisconsin Improvement Company, pursuant to an act to secure the enlargement and immediate completion of the improvement of the Fox and Wisconsin rivers, and the payment of scrip and other evidences of indebtedness issued by the State on account of the same, and for the protection of the settlers on the even sections, approved October 3, 1856, and under the powers contained in said act, or in the deed of trust executed by said company pursuant to said act, and under and pursuant to the judgment or order of the circuit court for the county of Fond du Lac, made on the 4th day of February, A. D. 1864, in a certain action therein pending, wherein the said trustees were plaintiffs and the said company and Abraham B. Clark, sole surviving mortgagee in trust, were defendants.

And further certifying:

The acceptance by the said purchasers of the rights, powers, privileges, franchises, capacities, immunities, and exemptions granted and conferred under and by an act of the legislature of the State of Wisconsin approved April 18, 1861, and the acts amendatory thereof.

And further certifying:

That in pursuance of the rights, powers, and privileges conferred as aforesaid, we have united and formed, and do hereby unite and form, ourselves into a corporation, under and by the name and style of the "Green Bay and Mississippi Canal Company," for the purposes expressed in, and with the rights, powers, privileges, franchises, capacities, immunities, and exemptions conferred by, the said last-mentioned act and acts. The capital stock of the corporation so formed to be $1,000,000, divided into 10,000 shares of $100 each; that the number of directors of such corporation shall be nine, and that the names of such directors for the first year, and until their successors shall be elected and qualified, are as follows: Samuel Marsh, Erastus Corning, Horatio Seymour, John MaGee, Edward C. Delevan, John Catlin, Erastus Corning, jr., George G. MaGee, and John S. Delevan.

And reciting a request to the trustees and referees making the sale:

To convey to such corporation so formed all the lands, water powers, franchises, and property sold and struck off to their agents and representatives at such sale as aforesaid, being all the lands, water powers, franchises, and property sold and struck off to their said agents and representatives as such at the sale aforesaid, being all the lands, water powers, franchises, and property acquired by or for the undersigned at such sale.

And also reciting that the trustees have submitted such request to the circuit court, and, by order of the court confirming said sale, have been authorized to convey the same in manner aforesaid.

These articles were acknowledged, and, with the schedules and exhibits therein referred to, are recorded in the record of the joint stock companies in the office of the secretary of state of Wisconsin, on the 15th of August, 1866, on pages 208–216.

And in pursuance of the order confirming such sale, and directing a deed thereof, made by the circuit court in Fond du Lac County as aforesaid, the trustees named did, on the 18th day of August, 1866, make a deed to the Green Bay and Mississippi Canal Company, whereby the said trustees did grant, bargain, sell, etc., to the Green Bay and Mississippi Canal Company, its successors, etc., all and singular the

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following described property, etc., and the right, title, interest, etc., which the parties of the first part, or either of them, as such trustees, referees, and mortgagees, in trust, have, of, in, and to the same, which are described as follows, to wit:

The works of improvement known as the "Fox and Wisconsin River improvement," together with all and singular the rights of way, dams, locks, canals, and other appurtenances of said works; the right of receiving tolls and rents for same, and all the privileges of said works, and all other rights, powers, and privileges by the State of Wisconsin granted to and vested in the Fox and Wisconsin Improvement Company, and its trustees, or either, under and by virtue of the several acts of the legislature of the State of Wisconsin in relation thereto, approved July 6, 1853, March 31, 1855, and October 3, 1856, and the acts amendatory thereof and proceedings thereunder, to which several acts of the legislature and the trust deed and mortgage referred to in the judgment under which the aforesaid sale was made, reference is hereby made for a fuller and more particular description of said works of improvement, rights, powers, privileges, etc. * * *

Also, all other corporate rights, privileges, franchises, powers, and property, real and personal, vested in and belonging to said company, its trustees, or both, forming a part of or in any way connected with said improvement, of whatever name or nature, and from whatever source derived, and all appurtenances thereunto appertaining, including and together *with all strips or parcels of land adjacent to said improvement, or the water powers created thereby, with such exceptions therefrom as are hereafter stated, which said strips of land are hereafter more particularly referred to; and also, all rights, titles, and interest in and to lands or other property acquired with reference to said improvement and water powers, through leases and agreements of all kinds.*

The following is a reference to the strips and parcels of land adjacent to said improvement and water powers above referred to and hereby conveyed; and also to the several deeds of conveyance of the same to said company, or its trustees, or both, to which said deeds reference is made for a more complete description than is herein given:

1. About 10.2 acres of land on the north half (½) of section number thirty-five (35), in township number twenty-one (21) north, of range seventeen (17) east, in the county of Outagamie and State of Wisconsin, lying on the south side of the Fox River and west of the plank road, of which 7.3 acres are north, and 2.9 acres south of the canal, subject to leases to Dunn & Brewster of a part thereof in connection with the water power. For a more perfect description of said premises reference is made to a deed of the same from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 10, A. D. 1855, and recorded in the office of the register of deeds for said Outagamie County, in volume 7 of deeds, on page 488.

2. About six (6) acres on the south side of the canal at Little Chute, in lot number one (1), in section number twenty-one (21), township number twenty-one (21) north, of range number eighteen (18) east, in said county of Outagamie. For a more perfect description of said premises reference is hereby made to a deed of the same from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 10, 1855, and recorded in the office of the register of deeds for said Outagamie County, in volume 7 of deeds, on page 488.

3. The "Little Chute Islands," so called, for a more perfect description of which reference is made to the deed from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 10, 1855, and recorded in the office of the register of deeds for Outagamie County, in volume 7 of deeds, on page 488; and also to the deed from Frederick J. Packard to J. F. Seymour, president, etc.

4. About six (6) acres on the south side of the canal at Little Chute, in lot number four (4) of section number twenty-two (22), township number twenty-one (21) north, of range number eighteen (18) east, in said county of Outagamie. For a more perfect description, reference is made to the deed from Theodore Conkey and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 19, A. D. 1855, and recorded in the office of the register of deeds for said county, in volume 5 of deeds, on pages 557 and 558.

5. About 7¼ acres on the south side of canal, or between canal and river, at Kaukauna, in or about private claim number one, for a more perfect description of which reference is made to the deeds from M. J. Mead to the president and directors of the Fox and Wisconsin Improvement Company, dated Aug. 14, 1855, and recorded in the office of the register of deeds for Outagamie County, in volume 6 of deeds, on pages 30–31, and from G. W. Law and wife to the same, dated Aug. 28, A. D. 1855, and recorded in said volume 6 of deeds, on pages 36–37.

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6. About 153.93 acres of land at Rapide Croche, being the south half (½) of the northeast quarter (¼), and lots four (4) and five (5) in section number four (4), township number twenty-one (21), range number nineteen (19) east, in said county of Outagamie. For a more perfect description of same, reference is made to the deed from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, and recorded in volume 9 of deeds, page 387, in the register of deed's office for said county.

7. Two lots, to wit, one-half acre of land adjoining the lower lock in the canal at Kaukauna, and one-half acre adjoining the lock next above the lower one aforesaid, which said lots are laid out in a square form in the county of Outagamie and State of Wisconsin. For a full description of said lots, reference is made to the deed from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 14, A. D. 1855, and recorded in the office of the register of deeds for said county, in volume 9 of deeds, on page 428.

8. All that part of lot number four (4) in section number twenty-one (21), town twenty-one (21), in range number eighteen (18) east, in the county of Outagamie and State of Wisconsin, lying south of the center line of the canal upon said lot; also, one-quarter of an acre lying on the north side of said canal, particularly described in the deed from Paul Thibeau to the Fox and Wisconsin Improvement Company, dated April 17, 1854, and recorded in the office of the register of deeds for said county, in volume 4 of deeds, on pages 343-344, to which reference is hereby made; also, a strip of land two rods in width, fully described in said deed from Thibeau, together with all other rights and privileges described and mentioned in said deed.

9. About 32.60 acres of land, situate in the county of Brown and State of Wisconsin, known and described as lot number five (5), in section number eighteen (18), in township number twenty-two (22) north of range number twenty (20) east, as described in a certain deed from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 10, 1855, and recorded in the office of the register of deeds of the aforesaid Brown County, in volume 8 of deeds, on page 168, to which said deed reference is hereby made.

10. About 51.35 acres of land in the county of Brown and State of Wisconsin, known as lot number four (4), in section number eighteen (18), township number twenty-two (22) north, of range number twenty (20) east, situate on the east side of the Fox River, and described in a contract for deed between the president and directors of the Fox and Wisconsin Improvement Company and the heirs and devisees of Robert Campbell, deceased.

11. Also, certain piece and lots of land at or near the village of Montello, in the county of Marquette, which was acquired and is now owned by the Fox and Wisconsin River Improvement Company and its trustees, or either, being all the real estate now held and owned by said company or its trustees at or near the place.

12. Also, each and every other piece or parcel of land or strips of land adjacent to said improvement or water powers, and used for the same, or valued in connection therewith, belonging to said Fox and Wisconsin Improvement Company, its trustees, or both, whether included in the above schedule or otherwise (if any such). Also, all the rights of way across or upon the lands of others belonging to said company, and its trustees, and all or either, and all rights of flowage upon the lands of others, whether acquired by grant, purchase, prosecution, or otherwise.

The foregoing strips or parcels of land are conveyed subject to all the leases of water powers heretofore made by the said company or its trustees, in any manner affecting the same, and all portions of the same which have been heretofore sold in connection with water powers, if any such, are hereby excepted.

SECOND.

All of the water powers created by and upon the line of, or connected with, the work of the Fox and Wisconsin River improvement was called, at whatever points located and wherever situated, estimated to be upon the lower Fox River line, exclusive of that at Menasha and Neenah, at least 28,788 horsepower. No estimates have been made of the amount at other points, or elsewhere upon the line of said improvement, together with any and all strips or parcels of land contiguous to and of a special use in connection with said water powers owned by the Fox and Wisconsin Improvement Company, and its trustees or either, together with all reversions, remainders, etc., excepting therefrom all water powers heretofore sold, if any such, and subject to all leases and agreements heretofore made by said company and its trustees, or either, now outstanding and legally binding upon them, or either of them. * * *

Which deed containing the above grants and conveyance was properly executed and acknowledged by the trustees and mortgagee, and fully complete for record on the 20th day of September, A. D. 1866, when the same was delivered.

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All of the granting part in said deed which is material or important to the questions involved in this report are hereinbefore set out.

The Green Bay and Mississippi Canal Company entered into the occupation and possession of the property so conveyed, including the water powers and franchises under the said deed, but soon came to the conclusion that there was a load of debt and liability hanging over the work which made its future not quite so rosy as it seemed before having actual contact with the situation. There were many acres of valuable land belonging to the company which it was desirable to keep. There were many claims, amounting to hundreds of thousands of dollars, for damages by reason of flowage that seemed a burden too great to be borne.

The expense of keeping and maintaining the dams and improvement would largely reduce, if not equal, any profit to be derived from the rental or use of water power, and so there appears in the legislation by the Congress of the United States, as early as July, 1870, an act entitled "An act for the improvement of the water communication between the Mississippi River and Lake Michigan, by the Wisconsin and Fox rivers," approved July 7, 1870, which act was the preliminary step in relieving the Green Bay and Mississippi Canal Company of its burdens growing out of its voluntary purchase of the rights, franchises, and property of the Fox and Wisconsin Improvement Company, with which the United States had had nothing to do, except the making of the munificent donation to enable the State to make the proposed and desired improvement, and of which the said canal company was measurably a beneficiary.

The language of the act is in some sense peculiar, and the peculiarity should be especially noted, because of its apparent assumption of wrong done to the company by the Government, and upon that assumption is based in a degree the act, in order to make amends for the wrongs so perpetrated. This is well to be kept always in mind, when the claims of the company under its deed are the subject of construction. By the terms of the act—

> The Secretary of War is authorized to adopt, for the improvement of the navigation of the Wisconsin River, such plan as may be recommended by the Chief of the Bureau of Engineers. * * * The Secretary aforesaid is hereby authorized to ascertain at any time he shall deem proper, within three years from the passage of this act, *the sum which in justice ought to be paid to the Green Bay and Mississippi Canal Company, a corporation existing under the laws of Wisconsin, as an equivalent for the transfer of all and singular its property and rights of property in and to the line of water communication between the Wisconsin River aforesaid and the mouth of the Fox River, including its locks, dams, canals, and franchises, or so much of the same as shall in the judgment of said Secretary be needed.*
>
> (NOTE.—The valuable donation of the United States lands remaining unsold is omitted from consideration in the doing of the act (styled an act of justice), and to that end is authorized to join with said company in appointing a Board of disinterested and impartial arbitrators, "one of whom shall be selected by the Secretary aforesaid, another by said company, and the third by the two arbitrators so selected. The Secretary aforesaid is authorized to employ a competent agent or attorney to represent the interests of the United States upon the hearing before said Board, provided that, in making their award, the said arbitrators shall take into consideration the amount of money realized from the sale of the lands heretofore granted by Congress to the State of Wisconsin to aid in the construction of said water communication, which amount shall be deducted from the actual sale thereof, as found by said arbitrators.")

This is a most gracious way of glossing over a purpose to induce the United States to assume and pay the debts and liabilities of an insolvent corporation that can be found anywhere upon the statute book. It is done so cleverly as not to shock the sense of propriety of any

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bucolic representative; and its success as an appeal from injured citizens who had made a mistake in investing their money was a foregone conclusion to all who know the slight pretext that furnishes an excuse for dealing with the rights and interests of the public by means and methods that would be scouted at in the transactions of private business. It can not even be surmised, it would seem, what on earth there was to arbitrate between the United States and a corporation that it never had anything to do with, and between whom no difficulties had arisen and no claims or pretended claims had sprung up.

Section 3 of said act provides for the filing of an agreement, in writing, by the company, to convey to the United States the property and franchise mentioned in the second section, upon terms awarded by arbitrators, and made it the duty of the Secretary of War to transmit a copy of the report of the arbitrators, upon which Congress at its then present session might elect to take the property and make an appropriation to pay the amount awarded, with the proviso that if the Secretary of War shall not transmit to Congress a copy of the report of the arbitrators sixty days before the close of the session Congress may, at its next session, make such election and appropriation.

Section 4 gives to the United States, for the benefit of the public Treasury, all the tolls and revenues derived from the improvement, after paying the current expenses of operating and keeping the same in repair.

Section 5 requires the Secretary of War to report annual progress in the completion of the improvements, the amount expended thereon, and the amount of revenue derived therefrom.

This act would seem to be but the beginning of the end, contrived by somebody to drive an entering wedge into the Treasury of the United States for the benefit of private interests, under cover of a pretense of public good.

The construction of the act last referred to in nowise was intended on the part of the United States to cover the large claim for damages which had been occasioned by the company in the construction of the so-called Fox and Wisconsin River improvement, and it does not seem to have been in the contemplation at all of the Congress who passed the act.

The Attorney-General of the United States, in an official letter dated November 10, 1875, to his special assistant at Fond du Lac, Wis., on the subject of claims for damages then made against the Government by reason of flowage, says:

> My investigations have led me to the conclusion that there was no understanding or agreement between the Green Bay and Mississippi Canal Company and the United States, at the time of the purchase by the latter, such as that suggested in the petition. * * *

He then recites and considers the acts of Congress leading to the purchase, and the acts of Congress subsequent to the purchase, and reiterates:

> There is no ground whatever, either in the proceeding of the arbitrators, the action of the Secretary of War, the legislation of Congress hereinbefore referred to, or in the instrument by which the transfer of the property was made, for alleging an understanding or agreement on the part of the United States at the time of the purchase to assume the payment of damages for flowage for which the said company was then liable.

And in the same letter he gives some data to show how much money had been appropriated from the Treasury from the time of the passage of the last act referred to up to November, 1875. I refer to it as fur-

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nishing very useful information in considering the question, if it ever should be considered, whether the public received any such benefit from the works as will warrant a continuance of any further expenditure:

Purchase money paid to the company	$145,000
March 3, 1873	300,000
June 23, 1874	300,000

This latter appropriation in the act of June 23, 1874, volume 18 of Statutes of the United States, page 237, contains the following language providing that—

Not exceeding $25,000 of the above may be used for the purchase of such real estate as may be required for right of way or for flowing, in the completion of the Fox and Wisconsin Improvement Company.

The extension of the liability of the United States to damages sustained by flowage here first crops out, and the step toward it is soft and velvety, worthy of the genius that drafted the original act providing for purchase.

By the act of March 3, 1875, there was an appropriation of $500,000, and in another act passed the same day the ground so elegantly prepared for the advance was occupied and an act passed with following provision:

In case any of the lands or other property is now or shall be flowed or injured by means of any part of the works of said improvement heretofore or hereafter constructed, for which compensation is now or shall become legally owing, and in the opinion of the officer in charge it is not prudent that the dam or dams be lowered, the amount of such compensation may be ascertained in like manner.

The act further provides for the Department of Justice representing the interests of the United States in legal proceedings, and provides furthermore—

That a portion of the appropriation made for the further prosecution of the improvement aforesaid, not exceeding in amount $25,000, may be applied in payment for the property and rights taken and used as aforesaid.

By this act the liabilities were completely saddled upon the United States, irrespective of whatever they might amount to, and the paltry sum of $25,000 was stated in the act as if to carry the impression that that would cover the amount of liability assumed, and not to awaken opposition, and thus not to arouse opposition from economists in the Congress. The aggregate of the claims under this provision allowed and paid it is not possible for me from any data that I have to state in full, but from my own personal knowledge they reach at least a quarter of a million, and in my judgment largely exceed that amount, and were only checked by an act of Congress cutting them off.

The appropriations for the so-called improvement have been made in each appropriation bill for the improvement of rivers and harbors from 1875, the date of the last appropriation given, up to the present time, but not so largely in amount, and will continue to be made so long as we have a Government, unless the diminutive character of any possible public benefit growing out of a continuance of the work shall impress the legislative conscience and cut off appropriations for works which, when completed, do little less than increase and benefit water powers belonging to private interests.

Under the act of Congress referred to, entitled "An act for the improvement of the water communication between the Mississippi River and Lake Michigan by the Wisconsin and Fox rivers," approved July 7, 1870, arbitrators were appointed to act in accordance with the provisions thereof, and entered upon their duties and made, as therein

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directed, a report, so much of which as is essential in the consideration of the deed from the Mississippi Canal Company to the United States is as follows:

REPORT OF ARBITRATORS.

* * * * * * *

What is meant by the sum which ought in justice to be paid, mentioned in the body of the section, and the actual value, mentioned in the proviso, from which the net proceeds of the lands granted are to be deducted? Actual value to whom? Value for what purpose? These questions are not entirely free from doubt.

If considered as a pecuniary investment, in its present condition the property is of little actual value to the canal company or to any other party. It pays but little revenue. Its revenues do not, in fact, pay expenses and repairs.

While it may be of very great value to the State, it has been for many years a source of expense to its proprietors. As a water channel it has and can have no value, therefore, except in the future, by becoming a part of a great through water route between the Mississippi River and Lake Michigan, a route, if once completed, of incalculable value to the people of all the States, East and West.

And it is in view of the fact that Congress may determine to take hold of that work as of national importance that this Board is called upon to act and determine its value. If Congress elects to take the improvement company, it is for the purpose of making it a part of that through route, and for that purpose only.

After hearing the parties and considering this question in all its bearings, the Board are of the opinion that the true question to determine is, What is the value of the improvement to the Government when taken for the purpose of making the same a part of a through route from Lake Michigan to the Mississippi River?

Congress, of course, does not desire to take it as a money investment, but to make it a part of a national highway of commerce; and, therefore, it would seem to be worth as much as it would cost to build such works at the present time, deducting a reasonable sum for depreciation by wear and decay. * * *

In this view of the case the Board have arrived at a determination of this question after long conference and balancing of opinion upon the question of value, costs, and depreciation, and have agreed to report that they find a value for the purpose above mentioned of all and singular the property and rights of property of the Green Bay and Mississippi Canal Company in and to the line of water communication between the Wisconsin River and the mouth of the Fox River, including its locks, dams, canals, and franchises, and including as fixtures attending the operation and repair of the same the dredge boats, dump scows, and all other articles of personal property mentioned in the list of personal property annexed to the testimony of B. B. Stevens, esq., in the appendix thereto, to be $1,048,070; and that the amount of money realized from the sale of lands heretofore granted by Congress to the State of Wisconsin to aid in the construction of said water communication, to be deducted from such value, $723,070, leaving a balance of $325,000 to be paid to the Green Bay and Mississippi Canal Company.

And whereas, under the said act the Secretary of War may, in his judgment, decide that such personal property may not be needed, and that a part of the franchises of the canal company, to wit, the water powers created by the dams and by the use of the surplus waters not required for the purposes of navigation, are not needed, and in order to enable said Secretary to pass judgment upon these questions, this Board have thought proper to appraise the value thereof respectively. They estimate and appraise the value of such water powers and locks necessary to the enjoyment of the same, subject to all rights to use the water for all purposes of navigation, as the same is reserved in all leases made by said company, and subject also to all leases, grants, and assignments made by said company, at the sum of $140,000, which said sum is to be deducted from the said sum of $325,000 in case the said Secretary or Congress shall determine that the said water powers are not needed for public use.

They also estimate and appraise the said dredge boats and other personal property mentioned in said list at the sum of $40,000, which said sum is to be deducted from said sum of $325,000 in case said Secretary or Congress shall decide that the same are not needed for public use. Along with said testimony contained in the appendix annexed is an abstract of title to said property, marked "AA," and two certain maps prepared by the engineer of the company, showing the works of the company and the locks and water power.

This report was dated November 15, 1871, and is on file in the office of the Secretary of War.

The report of D. C. Houston, major of engineers, having charge of the Fox and Wisconsin River improvement, dated February 26, 1872,

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contains certain statements of fact and scientific opinion which may become material, and are, therefore, herein repeated.

* * * * * * *

Does the Government need this water power for the purposes contemplated in the act of Congress, to wit, the improvement of this line of navigation? The water power for which the award is made is a limited franchise, as stated in the award of the Board, and is subject to all rights to use the water for all purposes of navigation.

It consists of certain water lots indicated in the map accompanying the report, and the right to use the water power created by the dams in those lots. * * * This water power does not comprise all the water power furnished by the river, nor all the power which is made available by the dams and canals of the company. To render all of this latter power available would require the construction of new feeders and the purchase of land, but this is not included in the award. If the Government should decide not to purchase this water power it would leave the company in possession of this water power, * * * and the right to use the surplus water in their own lots. The additional water power created by the present works of improvement, and such as might be created in future by works for further improvement, would be entirely under the control of the Government. In an engineering point of view it does not seem that these water lots are needed by the Government any more than any other land adjacent to the works and owned by private parties. The main question is, "Does the right of the canal company to use the surplus water involve any right to interfere with the construction, control, management, and repair of its works by the United States?"

Inasmuch as the subject of navigation is primary, and this water-power franchise is limited, as stated in the award, I can not see that it does.

If not, then it does not seem desirable for the Government to make the purchase, for it would become involved in negotiations with private parties desiring to rent water power, the collection of rent, and perhaps litigation. These matters should be left with the company if possible. If the company or parties to whom it should convey its rights in this water power should wish to use the water, it would be for the Government, as the owner of the improvement and controller of the navigation, to decide whether the latter would be interfered with, and the manner in which the flumes should be constructed, in the same way as the company has done heretofore.

This reference is made to show cotemporaneous construction of the award of the arbitrators by the officers of the Government having the work in charge, and which were submitted to the Government before their action was taken upon the report of the arbitrators (see report of Secretary of War, hereinafter cited), and which it is not improper to infer entered into the consideration of the Government in its acceptance of the report.

The report of the arbitrators was submitted by the Secretary of War to the House of Representatives under communication of March 8, 1872, as required by the act approved March 7, 1870.

The Secretary approves of the award as reported by said arbitrators, and he reports to Congress that $325,000 is the sum which, in his opinion, ought in justice to be paid to said corporation as an equivalent for the transfer to the United States of all the property, rights, and franchises embraced in said award, provided Congress shall determine to purchase the whole thereof.

The Secretary is of the opinion that the personal property appraised by said arbitrators at $40,000 is not needed for public use. He is further of the opinion that the franchises of said corporation that are appraised by said arbitrators at the sum of $140,000 are not required for purposes of navigation, and are therefore not needed.

Deducting the above valuations of property, franchises, etc., which, in the opinion of the Secretary, are not needed, within the meaning of that word as used in said act, the valuation remaining of the property, franchises, etc., is found by said arbitrators as $145,000.

The Secretary reports to Congress that all the property, franchises, etc., so valued at $145,000 are needed for the purposes of navigation, and that said amount of $145,000 is the sum which, in his opinion, ought in justice be paid to said corporation as an equivalent for the transfer to the United States of said property, franchises, etc., so needed. * * *

The Secretary has been aided in forming his opinion in this case by the report of Maj. D. C. Houston, United States engineer in charge of the survey and improve-

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ment of the Fox and Wisconsin rivers, a copy of which report is transmitted with the report of the Secretary.

The United States, by act of Congress entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," approved June 10, 1872, among other things, provide:

For payment to the Green Bay and Mississippi Canal Company, for so much of all and singular its property and rights of property in and to the line of water communication between the Wisconsin River and the mouth of the Fox River, including its locks, dams, canals, and franchises, as were under the act of Congress for the improvement of water communication between the Mississippi River and Lake Michigan by the Wisconsin and Fox rivers, approved July 7, 1870, reported by the Secretary of War to be needed, in his communication to the House of Representatives dated March 8, 1872, $145,000.

This legislation and these reports contain a full statement of the contract and agreement between the United States and the Green Bay and Mississippi Canal Company. The terms of purchase, the price to be paid, the property to be bought, are all distinctly and clearly stated. No conditions could legally be added thereto by the company. Nothing could be legally deducted therefrom by the United States. Omitted equities, if any there be, that have since been discovered can not alter or change the legislation and the terms of purchase.

Clauses of exception or reservation in the deed, which might vary its effect and change it, and upon its face seem to change its legal import, so as to alter the power given by Congress to purchase and create limitations upon the grant made, if there should be any, must all be construed by the preceding legislation, and nothing can be taken by inference or argument which shall alter the plain import and meaning of the acts authorizing the making of the purchase and transfer.

This legislation and the acceptance of the money consideration provided by Congress of itself passed the title of the Green Bay and Mississippi Canal Company to all the property purchased to the United States, irrespective of any deed by the company.

There seems to be, however, arising claims of construction of clauses in the deed, limiting the rights and powers of the Government, and imposing burdens upon it by implied covenant, which require a consideration of the import of the deed construed by the light of legislation, which we have considered.

It is not disputed that all of the rights of the Fox and Wisconsin River Improvement Company and the State of Wisconsin in and to the works and property transferred to the Green Bay and Mississippi Canal Company, by conveyance hereinbefore specified, passed to the latter company upon the execution of the deed of the trustees to it.

What property passed under the legislation providing for a purchase by the United States from the Mississippi Canal Company, and the conveyance of the company, comes now directly to be considered in its order in making this report.

The portions of the deed under which special claims are made by the company will now be given consideration.

The deed commences with a recital and reference to the act of Congress approved July 7, 1870, entitled "An act for the improvement of the water communication between the Mississippi River and Lake Michigan, by the Wisconsin and Fox rivers."

And following it comes a recital of the action of the Board of Arbitrators; and following it the action of the Secretary of War upon the judgment of the Board; and following it a recital of the act of Congress entitled "An act making appropriations for the repair, preserva-

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tion, and completion of certain public works on rivers and harbors, and for other purposes," approved June 10, 1872:

For payment to the Green Bay and Mississippi Canal Company, for so much of all and singular its property and rights of property in and to the line of water communication between the Wisconsin River and the mouth of the Fox River, including its locks, dams, canals, and franchises, as were under the act of Congress for the improvement of water communication between the Mississippi River and Lake Michigan by the Wisconsin and Fox rivers, approved July 7, 1870, reported by the Secretary of War to be needed, in his communication to the House of Representatives dated March 8, 1872, $145,000.

Next follows the granting clause of the deed:

That in consideration of the premises, and fully to comply with the requirements of the act of Congress approved July 7, 1870, and to accomplish the intents and purposes thereof, and in consideration of the sum of $145,000, the receipt whereof is acknowledged by the company.

The description of the property conveyed is as follows:

All and singular its property and rights of property in and to the line of water communication between the Wisconsin River aforesaid and the mouth of the Fox River, including its locks, dams, canals, and franchises, *saving and excepting therefrom and reserving* to said party of the first part the following described property, rights, and portions of franchises, which, in the opinion of the Secretary of War and of Congress, are not needed for public use. * * *

All that part of the franchises of said company, to wit: The water powers created by the dams and by the use of the surplus water not required for the purpose of navigation, *with the rights of protection and preservation appurtenant thereto*, and the lots, pieces, or parcels of land necessary to the enjoyment of the same, and those acquired with reference to the same, all subject to the right to use the water for all purposes of navigation, as the same is reserved in leases heretofore made by said company, a blank form of which, attached to said report of said arbitrators, is now on file in the office of the Secretary of War, and to which reference is here made; and subject to all leases, also, and grants and assignments made by said company, said lease, etc., being also reserved therefrom. Together with all and singular the hereditaments and appurtenances unto the above granted and described property, rights, and franchises not so saved and accepted or reserved, belonging or in any way appertaining, and all the estate, right, title, interest, claim, or demand whatsoever, of said party of the first part, either in law or in equity, either in possession or expectancy, of, in, and to the above granted property, rights, and franchises not so saved, excepted, or reserved, and their hereditaments and appurtenances.

To have and to hold the above-granted and described property, rights, and franchises, not saved, excepted, or reserved, and every part and parcel thereof, etc.

The deed bears date July 7, 1870.

It can hardly be claimed that if this deed be construed as a deed to comply with the requirements of the act of Congress, and to accomplish the intents and purposes thereof, that the words, "saving and excepting therefrom and reserving to said party of the first part the following described property, rights, and portions of franchise, which, in the opinion of the Secretary of War and of Congress, are not needed for public use, to wit: All that part of franchise of said company, the water power created by the dam, and by the use of the surplus water not required for the purpose of navigation, with the rights of protection and of preservation appurtenant thereto, and the lots, pieces, or parcels of land necessary to the enjoyment of the same, and those acquired with reference to the same," that the interpolation of the language just cited as an exception or reservation in the deed, can be construed to create an implied covenant on the part of the Government to keep and maintain dams, under all circumstances, by which the water powers should be preserved.

No such contract or agreement, or language tending to make one, crops out anywhere in the legislation which this deed purports to carry into execution, and the legislation and the deed are all to be construed

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in pari materia. The rule of construction of such language in a deed, if it were therein inserted by authority, has been fully settled by the supreme court of the State of Wisconsin. The construction to be given in an exception in a grant of land should be construed strictly against the grantor, and an exception is none the less an exception because in the form and terms of a reservation. (G. B. &. M. Canal Co. *v.* Hewitt, 66 Wis., 461.)

It is an unauthorized interpolation of words in a deed not contemplated in the bargain and purchase, and is, therefore, in my judgment, of no force and effect as a basis for any such implied convenant as is contended for by the grantor in the deed.

The proposed sale of dams, canals, and locks was absolute and unlimited. No restriction or reservation of any kind was contemplated anywhere, and it is too late now to attempt to graft one onto the contract by implication.

The sale of the property intended to be conveyed was absolute, and without any restriction or reservation.

The grant of a mill dam carries with it the title to the land on which it rests, the right of ingress and egress to it, and the use of so much of it as shall be necessary to enable the grantee to enjoy the benefits of his grant. Or, as Washburn puts it—

> A grant of a thing will include whatever the grantor had power to convey which is reasonably necessary to the enjoyment of the thing granted.

A water power is an incident to riparian ownership. It can not accurately be called an appurtenant to a dam. It is an appurtenant to the shore, and the dam is an improvement of the power. It is said that—

> Whatever is properly appurtenant to the principal thing granted passes with it. * * * A thing appendant or appurtenant is defined to be "a thing used with and related to or dependent upon another thing more worthy, and agreeing in its nature and quality with the thing whereunto it is appendant or appurtenant."

The language of the deed is "saving and excepting therefrom, and reserving to said party of the first part, the following-described property rights and portion of franchises," etc. The explanation of what is meant by this language will be found under the heads of "First" and "Second," stated in the deed.

The words "the following described property," relate simply to the property described in the first specification. "All the personal property of said company, and particularly all of such property described in the list or schedule attached to the report of said arbitrators, etc., * * * whether or not such property be appurtenant to said line of water communication;" that answers the first reservation, and no one pretends that any such property was purchased, but, on the contrary, it was expressly excluded from the terms of purchase by the act of the Government.

"Rights and portions of franchises." What is meant by these words is to be construed in reference to the second classification. All that part of franchise of said company, to wit, the water powers created by the dams and by the use of the surplus water not required for the purposes of navigation. What franchise does this mean? No franchise, certainly, conferred by the United States. But it means simply the right to the use of the water given in the original act of the State authorizing the improvement, subject to a primary servitude to the Government for its use for the purposes of navigation.

"With the rights of protection and preservation appurtenant thereto." The right of preservation and protection of franchise is not an appurte-

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nant to the real estate, so that it is not and can not be an appurtenant to any of the realty conveyed by the company to the United States under the general term of "milldams, locks," etc. If that right can be called an appurtenant to realty at all, it is appurtenant to the lots, pieces, or parcels of land which are reserved from the grant, and which are shown upon the map which accompanied the report of arbitrators as land necessary to the enjoyment of the same, and those acquired with reference to the same.

The term "franchise" here used does not mean any right acquired by riparian ownership, but is a separate and distinct right in the use of a thing acquired by grant from the State. It is an intangible thing.

"Franchises," said Chief Justice Taney, "are special privileges conferred by Government upon individuals, and which do not belong to the citizens of the country generally, of common right. It is essential to the character of a franchise that it should be a grant from the sovereign authority, and in this country no franchise can be held which is not derived from a law of the State." (Bank of Augusta *v.* Earl, 13 Peters, 595.)

The franchise granted to the Green Bay and Mississippi Canal Company through the conveyance made to it of the Fox and Wisconsin Improvement Company's locks, canals, water powers, etc., was a franchise which related to the use of the particular thing. It gave no riparian right to anybody. That had to be acquired in the case of the Green Bay and Mississippi Canal Company and its grantors. The franchise granted was the use of the water running over the dams and through the canals and locks created for the purposes of navigation, which were not required by the Government for purposes of navigation, and were strictly subject to limitation by that right in and requirement of the Government. It does not seem that it may be well argued that such a franchise as that carried with it as an appurtenant a milldam owned by other and different parties. Besides, it is entirely repugnant to the idea of the purchase of dams by the Government, and of the use of the dams and canals leading therefrom by the Government under its sovereign and superior right, that in its contract it should provide that that use might be interfered with and disturbed by a person or corporation owning a franchise, in the use of the surplus water flowing over the dam and through the canals and locks not required by the Government for purposes of navigation.

That use gave no right in the dam or improvement creating the surplus water, and hence it seems necessarily to follow that the canal company have no right to tap the canals leading to the locks and draw water from them for water-power use. If the abstract right even should be conceded, no limit to it could be fixed, except as the result of litigation, and it is not to be presumed that the Government took this improvement with any agreement or understanding with private parties which could open the door to friction necessarily resulting from the exercise of power by private individuals to tap the canals.

Therefore it is submitted that the reservations in the grant as a basis for the claim now made under them is entirely repugnant to the legislation authorizing the grant; and, second, if any force is to be given to the words, as having any relation to the dams, locks, and canals, "with the rights of protection and preservation appurtenant thereto," those words must be construed with reference to the absolute superior right and control of the Government to do as it chooses with reference to the exercise of its power to improve navigation, and is subject thereto, and these words can only be made applicable to a right to enter

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upon and interfere with the dams, locks, or canals when, if ever, the Government shall decline longer to keep and maintain the dams or attempt to use the water in aid of navigation, and the work shall be abandoned as a public work, and the rights of riparian owners shall once more become paramount.

The deed is, of itself, a monument to the confiding trust of the United States in its citizens, even though they be corporations. There is not one piece of property described in it with definite certainty. There is not a single covenant in it. The location of what it is manifest was intended to be conveyed can only be discovered with an engineer's compass and chain and from information *dehors* the deed.

After very careful examination and reflection I have ascertained and determined, from the best information possible within my resources and research, that for many parts of the public work shown upon the maps returned herewith the most reliable title upon which the Government can rest its claim depends and rests very largely upon possession and occupancy, applying the rule laid down in 142 United States, 277, cited supra, that a grant can be and will be presumed, after so many years' lapse of time, where provision had been made by law for the payment of damages, if any were claimed, at the option of the owner.

So, then, it is my judgment that wherever lands were taken under the direction of the State of Wisconsin through its board of public works for the improvement of the Fox and Wisconsin rivers and the canal connecting the same the title of the United States to the lands actually occupied by such improvement, whether by dam, or lock, or canal, is perfect in the United States, but when the boundaries are to be defined as to the extent of the holding there will continually arise friction.

The only light that we can have, and it is a very good one, will be found in a descriptive note to the maps showing the canals, locks and dams, and water-power lots of the Fox and Wisconsin Improvement Company, made by Daniel C. Jenne, chief engineer, in 1859, and which were used before the arbitrators, and are on file in the office of the Secretary of War. From this we can get measurably and approximately with accuracy the lines of the property actually taken; and, also, we can get the water-power lots mentioned in the deed, portions of which, necessary to the use of the water power, are reserved in the deed. This note reads, as descriptive of the maps upon which it appears:

> The red line is the base of the survey. The full red transverse lines indicate angles and the *blue line the outer bounds of the land appropriated for the benefit and use of the improvement.* The figures on the dotted red transverse lines indicate distances from the last angle, those on the full red transverse lines the long preceding courses, *and those along the blue line its distance from the base.* The water-power lots are numbered with small figures and the blocks with large figures, and the lots are tinted in orange.

Here is given the only certain key that I can find to the boundaries when the Government claims under a presumptive grant, under which the Government can hold by a presumptive grant.

The arbitrators report, as a part of an appendix accompanying the same, abstracts of all the title of the Green Bay and Mississippi Canal Company to the property proposed to be transferred from them to the United States, which abstracts, if correct, furnish to the Department and the Government the exact information sought by the report committed to me to make.

I have been fortunate enough to discover that the canal company, by mesne conveyances, had title to a considerable portion of the works of

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improvement at the time of the transfer to the United States. But not resting my report upon the general proposition of the right in the Government hereinbefore stated, I will consider the title of the Government in the canals, dams, locks, and property adjacent thereto, specifying the same in each case, so as to show what title the Fox and Wisconsin Improvement Company had which it conveyed to the Mississippi Canal Company, which would pass by the transfer from the Mississippi Canal Company to the United States. And in doing so I will state at what points the Mississippi Canal Company have now title acquired since the transfer to the Government; and in order to understand of what value and force and effect such after-acquired title may be considered, in support of the title of the Government, will cite authority to show. And here, again, the maps presented by the company to the arbitrators, showing the line of property and the extent of it, and which it was impliedly, if not directly, asserted it was the intent to pass from the company to the United States, become important in considering what effect could be given after-acquired rights by the canal company as a title hostile to the title of the United States. And upon this point the Supreme Court of the United States have laid down the rule to be:

That whatever may be the form or nature of the conveyance used to pass real property, if the grantor sets forth on the face of the instrument, by way of recital or averment, that he is seized or possessed of a particular estate in the premises, and which estate the deed purports to convey; or, what is the same thing, if the seizure or possession of a particular estate is affirmed in the deed, either in express terms *or by necessary implication*, the grantor and all persons in privity with him shall be estopped from ever afterwards denying that he was so seized and possessed at the time he made the conveyance. *The estoppel works upon the estate and binds an after-acquired title as between parties and their privies.* (Ryan *v.* U. S., 136 U. S., p. 88 of Opinion.)

In taking up the several points seriatim, the report will commence with the Portage Canal making the connection between the Wisconsin and the Fox rivers.

PORTAGE CANALS AND LOCKS.

At this point the board of public works, appointed under the authority of the State of Wisconsin in the original acts providing for the improvement of the Fox and Wisconsin rivers, took possession and appropriated certain lands for the use of the improvement in the construction and maintenance of the canal making the connection between the two rivers. The authority to make this appropriation fully appears in the legislation of the State of Wisconsin, hereinbefore specifically referred to. There appears upon the minutes kept by said board of public works, all its proceeeings, dated at Fort Winnebago, July 3, 1851, as follows:

The board of public works of the State of Wisconsin have reserved for the use of the State the following lands in the vicinity of lots number one (1) and two (2), and of the canal connecting the Fox and Wisconsin rivers. First, starting from a stake on the bank of the Wisconsin River fifty-one (51) links south two (2) degrees and fifteen (15) minutes east from the southwest corner of the warehouse belonging to Dempsey & Christopher; thence running north ten (10) degrees west one (1) chain and twenty (20) links; thence running north thirty-eight (38) degrees and thirty (30) minutes east eighty-one (81) links; thence running north fifteen (15) degrees and fifteen (15) minutes west five (5) chains and fifty (50) links, to a stake on the bank of the Wisconsin River, and thence down the Wisconsin River to the place of beginning.

Also, a strip of land along the line of the canal, of one hundred and ninety (190) feet in width, including the canal, the boundary on the towpath of the side running parallel with the inside of the top of the towpath bank, at a distance of forty (40) feet, the boundary on the opposite side running parallel with the inside of the

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top of the towpath bank at a distance of one hundred and fifty (150) feet from that line.

Also, starting from a stake on the bank of the Fox River twelve (12) chains and seventeen (17) links north twenty-seven (27) degrees west from the southwest corner of breast lock number two (2); thence running south thirty-two (32) degrees west six (6) chains and ninety-four (94) links; thence running south three (3) degrees west fifteen (15) chains and thirty-seven (37) links; thence running south fifty-three (53) degrees east nine (9) chains and fifty-six (56) links to a stake on the bank of the Fox River; thence down the Fox River to place of beginning.

This appropriation of land ripened into a title, within the rule laid down in 142 U. S., cited supra.

It is the strip connected with the canal that we have more particularly to deal with, as persons have set up a claim of adverse possession to the land along the banks of the canal and clear up to its margin, insomuch that employees of the Government, under its direction, seeking to repair the canal, have been prosecuted in trespass for going upon the adjoining land.

We have already seen, by the authorities from the Federal courts cited, that no adverse possession can run against the United States, and a comparison of dates will show that at the time of the transfer to the United States, which clearly covered this canal and the lands adjacent, so appropriated by the Government, no title by adverse possession could have been acquired against the State or its grantees. Hence, in my opinion, the title of the Government to the canal and the lands adjoining is absolute, and there follows from this conclusion, as matter of course, that the title to the land adjacent to the locks is also vested in the Government.

GOVERNORS BEND.

At Governors Bend there is a lock, dam, and canal. There is no paper title to be found which would place the land taken and used for public work in either of the companies or in the United States. The title of the Government must rest absolutely upon its right acquired under a presumed grant by reason of the taking and occupation of realty, which was done in 1863, and the right to use the same has from that time until this remained unchallenged.

The rule for determining the quantity of land to which this title attaches is the rule hereinbefore referred to such land as was actually taken in the construction of the work and used in keeping and maintaining the same.

It appears upon the records that the title of record is vested in one John F. Seymour, who was connected with the work of improvement in its earlier days, and presumably the land was taken and used, and has since been used and occupied, by his consent, as being an essential to the great work of improvement in which he was interested, while the lands themselves were of but nominal value, not equaling the benefit expected to be derived from the completion of the improvement.

Mr. Seymour is dead; but upon application to the land office of the canal company information was derived that negotiations were pending between the company and the heirs of Mr. Seymour to perfect the title of the land in the company, which would inure, by way of estoppel, to the benefit of the United States.

MONTELLO.

The works at Montello were begun by the Fox and Wisconsin Improvement Company in 1856, abandoned in 1857, and subsequently completed by the Green Bay and Mississippi Canal Company in 1868.

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The title to the land taken and used for public purposes at this point rests upon possession, occupation, and a presumed grant. There is no paper title whatever to support the title of the Government. There is no doubt, however, that the title to the land is in the Green Bay and Mississippi Canal Company, in equity, and that that title inures to the benefit of the United States. The title to that land and other lands upon the record appears in N. M. Edwards, who is an engineer in the employ of the Green Bay and Mississippi Canal Company, and who purchased the land for the use and benefit of the Mississippi Canal Company, and has expressed his willingness to make conveyance of the same when he shall be requested.

The next points in order, as they appear on the descriptive map of the Fox River, where improvements have been made, either by the canal company or by the Government, are Grand River, Princeton, White River, Berlin, and Eureka, at each of which points the land used for public work was purchased and paid for by the United States, they receiving no claim of title of any kind from the Green Bay and Mississippi Canal Company.

In addition to the improvements at the points hereinbefore specified, there is upon the upper Fox River certain other improvements termed "cut-offs," one below Governors Bend; one below Montello lock; one at a point known as Maple Bend, below White River lock; one at Shipley and Willow Bend, below White River lock; one 4 miles below White River lock; one at Big Horseshoe Bend, 2 miles above the Berlin lock, and one half a mile below the Marquette lock, all of which appear in the report of Capt. George A. Zinn, of the Board of Engineers, for the year 1897. The title to the land used for the purposes of these cut-offs was acquired directly by the United States, and the Green Bay and Mississippi Canal Company had nothing to do with them.

MENASHA AND NEENAH.

At Menasha, the United States through the Green Bay and Mississippi Canal Company, by mesne conveyances from the riparian owners with well-defined descriptions, own all of the land connected with the public works, including locks and canals, and no question can be made successfully as to the perfection of that title.

The rights of the Government at Neenah, in the Neenah Channel, have been by me in the earlier portion of this report clearly stated in the opinion of the referee, and nothing has come to my knowledge which can change the opinion given with reference thereto, but on the contrary, in support of the view by me given, it appears that in August, 1885, the United States through condemnation proceedings (records of which are in the office of the Secretary of War or of the Attorney-General) purchased land for widening the outlet of the Neenah Channel by dredging, presumably with the assent and approval of the corporation that now claims exclusive rights in the channel.

APPLETON.

The investigation of the title from this point, down to and including the dam at Depere, may be as it seems to me, best commenced by reference to the description contained in the deed from the trustees, etc., of the Fox and Wisconsin River Improvement Company to the Green Bay and Mississippi Canal Company, hereinbefore made part of this report.

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This seems to be the best starting point, because it is here that we find the first descriptions by metes and bounds of the lands purported to be conveyed to the canal company and appurtenant to the works of improvement. The language of the former deed is as follows:

> The following is a reference to the strips and parcels of land adjacent to said improvements and water powers above referred to and hereby conveyed, and also to the several deeds of conveyance of the same to said company or its trustees, or both, to which said deeds reference is made for a more complete description than is herein given.

And in the reservation made in the transfer from the Green Bay and Mississippi Canal Company, there are reserved:

> The lots, pieces, or parcels of land necessary to the enjoyment of the same, and those acquired with reference to the same.

Now, by the aid of the maps that were used and made a part of the arbitrators' report, we can determine the description of the lots, pieces, or parcels of land that are covered by this reservation, as necessary to the enjoyment of the water power, by noting that such lots are tinged in orange, in order to give the arbitrators a distinct information as to what the reservation intended to cover.

Without these reservations, we find from reference to the former deed, that 10.2 acres of land were conveyed by the Fox River Improvement Company to the Green Bay and Mississippi Canal Company, on the north half of section 35, in township 21, north of range 17 east, in the county of Outagamie and State of Wisconsin, lying on the south side of the Fox River and west of the plank road, of which 7.3 acres are north and 2.9 acres south of the canal, referring for a more perfect description of the land to a deed from Morgan L. Martin and wife, dated July 20, 1855, to the president and directors of the Fox and Wisconsin Improvement Company, and recorded in the office of the register of deeds for Outagamie County, Wis., in volume 7 of deeds, on page 488.

All of this land passed to the United States under the transfer of the property of the Green Bay and Mississippi Canal Company to the United States, except those lots, pieces, and parcels of land which, upon the map, are tinged with orange.

There is no dispute of the title of the Government in the lots occupied by canals, dams, and locks in connection with the improvement at Appleton. There is a dispute as to the ownership of certain lands hereinbefore described, and which are not excepted upon the maps, as to whether the same belong to the United States, or are still in the Green Bay and Mississippi Canal Company. These lands which the company claim, and which are not marked within the reservation, are the lands which will be found on the first map of the engineer, marked "Appleton," and are between the lines of the orange-tinted reserved lots and the canal, marked "contemplated basin," and include all of the land between the canal and the reserved lots, including that strip upon which appears, as marked upon said map, "A collector's office," and also includes between the street marked "Mill street" and the Fox River the land marked as "F. & W. Improvement Co."

I can not escape the conclusion that these two pieces of land last named are not within the exceptions in the transfer, and that each and both of them were purchased as part and parcel of the lands necessary for the improvement of the Fox and Wisconsin rivers, and passed to the United States as much as they passed from the Fox and Wisconsin Improvement Company to the Green Bay and Mississippi Canal Company.

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There is, also, at the first lock in Appleton, a piece of land to which the United States, in 1892, acquired title through condemnation proceedings, for the location of the lock, house, and warehouse, and to which the legislature of the State of Wisconsin ceded its jurisdiction to the United States under an act entitled "An act ceding jurisdiction over land purchased in the State of Wisconsin by the United States, for improvements of rivers and harbors," approved April 19, 1895.

This is independent of any transfer by the Green Bay and Mississippi Canal Company.

There is a speck of war growing out of a dispute as to the extent of the Government's right at the Telulah water power on the fourth dam at Appleton (a map descriptive of which water power and improvement is herewith reported).

It is very certain that at the time of the transfer of the works of improvement, locks, dams, and canals, by the Mississippi Canal Company to the United States, there was no title apparent in the Government to the land then occupied by such improvement, except such title as attached to the presumed condemnation and payment of damages resulting from the taking of such property for use, the provisions made for the payment thereof, and the lapse of time following.

The description of the lands upon which the canal and lock is situate, and out of which the trouble grows, is that part of lot 3 in section 25, and that part of the northern portion of lot 1, section 36, in town 21, range 17, adjoining the United States Government canal and the river. The dispute is not as to the right of the United States to the land taken and used, but is as to the extent of the boundary to which the United States has a right to make claim, presenting precisely the difficulty which I have before mentioned in this report as attendant upon the establishment of the title, without boundaries fixed and defined to determine the boundaries and extent of it.

The land of lot 3 south of the Fox River, in section 25, town 21, range 17, was originally entered from the Government by Walter L. Newberry, August 31, 1835.

Without any conveyence shown from Newberry of record, certain parties on May 4, 1859, entered into a land contract, directly recognizing the works of the improvement company at that point across sections 25 and 36, by a land contract, making the boundaries of the lands proposed to be conveyed or leased commence at a post 20 feet from the water's edge in the improvement company's canal which stands north 31 degrees 30 minutes east 9 chains and 95 links from where the east and west line between sections 25 and 36 intersects the canal, etc. And having, among other provisos, this one:

> if Walter L. Newberry, who is interested in the said land, shall not concur in the agreement, it shall be void.

There is of record also a survey and description of a tract of land in sections 25 and 36, town 21, range 17, made April, 1859, and recorded in Outagamie County, March 3, 1860, by one Ernst F. Petschke, which recognizes the existence of the works of improvement across these same lots. The description reads:

> Beginning at a point near the 4th lock of the Fox and Wisconsin improvement canal, where the east and west line between section twenty-five (25) and thirty-six (36), town twenty-one (21), range seventeen (17) east, intersects the south bank of said canal, 17.21 chains, or 1,136 feet, west of the quarter post in said line, bearing from that point 657 feet, and being 20 feet from the water line in said canal in a southeasterly direction, it being the point "A" on accompanying map; thence north thirty-four (34) degrees thirty (30) minutes east 2.51 chains, or 165 feet; thence south fifty-five (55) degrees thirty (30) minutes east twenty (20) chains, or 1,320 feet;

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thence south thirty-four (34) degrees thirty (30) minutes west 2.50 chains, or 165 feet; thence north fifty-five (55) degrees thirty (30) minutes west to the point of beginning, containing five (5) acres.

We have here two substantial recognitions of the occupancy of the land by the canal, locks, and dam, showing that the same had been taken and appropriated in aid of the work of public improvement under the power given the company by the State, and with the tacit assent of the landowner.

The pertinency of this recognition can not be avoided, because W. L. Newberry gave an agreement providing for a donation of this land described in the last survey for the purpose of having a paper mill erected upon the water power created by the canal and improvement.

On the 22d day of October, 1860, Walter L. Newberry conveyed the land described in the land contract of May 4, 1859, hereinbefore referred to, to prove knowledge and recognition of the existence of the Government works.

And again, on September 1, 1865, the grantees of Newberry, in the conveyance last above referred to, accepted a lease of the Fox and Wisconsin Improvement Company of the water power to be drawn from the canal at Appleton, above the fourth lock, on lot 1.

Again, on the 23d day of November, 1867, Walter L. Newberry conveyed to the city of Appleton a strip 4 rods wide, the center line of which is to begin on the south bank of the canal at a point 33 feet west of the northwest corner of G. N. Richmond's land—again recognizing the existence of the canal.

Again, April 3, 1874, E. W. Blatchford and William H. Bradley, trustees of the estate of Walter L. Newberry, deceased, make contract for sale of land to one J. E. Harriman, the description of the land being part of lots 2 and 3 of section 25, town 21, range 17.

And, also, the same trustees gave a land contract, dated July 1, 1874, to J. E. Harriman for sublot 1 of lot 3, in section 25–21–17, and also that part of sublot 2 in lot 1, section 36, lying north of South River street.

February 16, 1881, Blatchford and Bradley, trustees under the last will and testament of W. L. Newberry, deceased, convey to Henry J. Rogers and August L. Smith the land hereinbefore described, as contracted to be conveyed by Newberry and wife to J. E. Harriman, which covers the land in 25 and 36 out of which the dispute arises.

Rogers and Smith, on the 13th day of May, 1881, conveyed upon the consideration of $1 to the Telulah Water Power Company, referring for description of property to the deed of Blatchford and Bradley as trustees, excepting and reserving such part of the land described therein as is contained in a deed from Smith and Rogers to Welcome Hyde, dated February 28, 1881.

As a matter of description of person it will be well to know that these grantors to the Telulah Water Power Company were both officers of the Green Bay and Mississippi Canal Company, so that they had notice at the time of their supposed purchase, and of their supposed conveyance, of all of the rights and equities attaching to the owner of the locks, dams, and canals crossing these lands or upon them, and of the fact that they were included in fact, if not by precise description, under the words "lands, locks, dams, canals," etc., transferred by the Green Bay and Mississippi Canal Company to the United States.

On June 2, 1882, the Telulah Water Power Company conveyed to the Green Bay and Mississippi Canal Company the land described in the former deed from Rogers and Smith to them, including in said description all lands and easements of every name, nature, and description

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lying in sublot 2 of lot 1, section 36, and sublots 1, 2, and 3 of lot 3, in section 25, all in town 21, range 17, which the grantor now owns or has power to convey, from whatever source such title or power to convey has been derived, upon the consideration stated in the deed of $2,300.

November 1, 1888, the heirs, who were the devisees of Julia Newberry, deceased, the wife of Walter L. Newberry, executed a deed of release of all right which she might have in sublot 1 of lot 3, section 25, town 21, range 17, and in sublot 2, lying north of South River street, lot 1 in section 36, to Elifalet W. Blatchford and William H. Bradley.

It is believed that this after-acquired title by the Green Bay and Mississippi Canal Company inured directly to the benefit of the United States and supports and strengthens its prior title and furnishes points and data from which the extent of its holding can be determined.

This, I think, closes all there is in which the Government is interested and about which any dispute exists, as in any of the Appleton dams, locks, or canals.

THE CEDARS.

The deed to the Green Bay and Mississippi Canal Company contains, under paragraph 8, the following description:

All that part of lot number four (4) in section number twenty-one (21), town twenty-one (21), range eighteen (18) east, in the county of Outagamie and State of Wisconsin, lying south of the center line of the canal upon said lot, and also one-quarter of an acre lying on the north side of said canal, particularly described in a deed from Paul Thibeau to the Fox and Wisconsin Improvement Company, dated Apr. 17, 1854, and recorded in the office of the register of deeds for said county in volume 4 of deeds, on page 343. Also, a strip of land two (2) rods in width, fully described in said deed from Thibeau, together with all other rights and privileges described and mentioned in said deed.

The land conveyed under this title extends north to the middle thread of canal and the north half of canal, but the north bank of canal and the north canal bank rest on title by presumption, but the dam landing itself is on land that the canal company had title to.

The United States is entitled to the use of the right of way which appears on the map of Jenne under the head of "Cedars," and to keep the same in repair under the deed from Thibeau, and is also entitled to the use of one-fourth of the lot upon which is marked on said map "house and barn."

LITTLE CHUTE.

At this point we find certain lots and parcels of land mentioned in the deed of the Fox and Wisconsin River Improvement Company, designated as "Number 2," being about 6 acres on the south side of the canal at Little Chute, in lot No. 1, in section 21, township 21 north, of range 18 east, referring for more perfect description to a deed of Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, dated July 10, 1855, and recorded in the office of the register of deeds in Outagamie County in volume 7 of deeds, on page 488.

There is no dispute arising upon the title of the Government to these lands, subject, of course, to the reservation for water-power purposes by the Green Bay and Mississippi Canal Company, marked upon the map with orange tint, and the Little Chute Islands, designated in said deed of the Fox and Wisconsin Improvement Company under the head of "Number 3," and referring for a description to a deed from Morgan L. Martin and wife, made to the president and directors of the Fox and

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Wisconsin Improvement Company, and a deed of Frederick Packard to the president of the Fox and Wisconsin Improvement Company, all of which are recorded in Outagamie County, in volume 7 of deeds, on page 488.

The Government, under the company, hold the property upon which the north and south abutments rest, and also the canal, the east dam abutment being deemed to be upon what is styled "private property." The west end of the dam the Government also has title to from the company. At the time of the transfer to the United States the canal continued down across land that the company did not own, but they have since acquired title thereto. This title has been acquired since about the year 1880 by the purchase of land across which the canal lays in it. The south dam landing stands upon land to which the Green Bay and Mississippi Canal Company have, since its transfer to the Government, acquired title.

The remainder is title by presumption, and the presumption in some instances is exceedingly questionable.

Under descriptive designation "4" in the deed from the Fox and Wisconsin Improvement Company there is described, among the parcels of land particularly designated, 6 acres on the south side of canal at Little Chute, in lot No. 4, section 22, township 21 north of range 18 east, referring for a more perfect description to a deed made by Conkey and wife to the president and directors of the Fox and Wisconsin River Improvement Company, dated July 19, 1855, and recorded in the office of the register of deeds for said county, in volume 5 of deeds, on pages 557 and 558.

The title to this land is undisputed in the Government through the company.

Under descriptive designation "5" in the deed to the Mississippi Canal Company there is described about 7½ acres on the south side of the canal, or between the canal and river at Kaukauna, in or about private claim No. 1, referring for better description to a deed from M. J. Mead to the president and directors of the Fox and Wisconsin Improvement Company, dated August 14, 1855, and recorded in the office of the register of deeds for Outagamie County, in volume 6 of deeds, pages 30, 31, and from George Law and wife to the same, dated August 28, 1855, and recorded in said volume 6 of deeds, on pages 36, 37.

This land was entered from the Government by Paul Ducharme September 30, 1835.

On the 10th day of September, 1852, George W. Law and his wife conveyed the other undivided one-half to M. J. Mead.

On August 14, 1855, M. J. Mead conveyed by warranty to the Fox and Wisconsin Improvement Company the other undivided one-half of the land, one undivided one-half of which was conveyed to Morgan L. Martin by George W. Law and wife by deed December 12, 1851.

On the 20th day of August, 1855, George W. Law and wife quitclaimed to the Fox and Wisconsin Improvement Company the land described in the deed from Mead to the company, by the deed of August 14, 1855, subject to the deed given to Morgan L. Martin.

In April, 1866, Martin had judgment in the circuit court of Brown County against the Fox and Wisconsin Improvement Company, and issued an execution thereon to the sheriff of Outagamie County, who levied upon and sold to him certain tracts of land, among others a piece of land described as follows:

Commencing at a point at the upper and western extremity of the canal at Kaukauna, but twenty (20) feet north of the northerly water line of the canal; running

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thence down and along the bank of said canal twenty (20) feet distant from the water line, as aforesaid, to the northerly line of the south half of private claim number 1, lately owned by George W. Law; thence following said northerly line of the south half of lot number 1, aforesaid, easterly to the Fox River at low-water mark; thence upstream along the margin of the Fox River to the upper extremity of the guard lock at the head of the canal; thence northerly to the place of beginning, including all the lands sold to Martin by Law by deed of September 12, 1851, and by Law to Mead by the deed of September 10, 1852, and by Mead and Law to the Fox and Wisconsin Improvement Company, and also the right of way of canal at that point.

And on the 23d day of December, 1871, Martin received sheriff's deed of such premises by reason of the relation existing between Morgan L. Martin as a contractor for the completing of the work of improvement.

The State of Wisconsin, in equity, was entitled to have a conveyance from Martin of the lands described in that deed, and previous to the time of levying said execution referred to, that right of the State of Wisconsin had passed to the Fox and Wisconsin Improvement Company by virtue of the acts of the legislature and proceedings had thereunder.

Previous to February 22, 1873, negotiations were entered into by the Green Bay and Mississippi Canal Company and Morgan L. Martin for the purchase of the interest acquired by said Martin in the lands formerly owned by the Fox and Wisconsin Improvement Company.

The result of the negotiations was a deed by Morgan L. Martin and wife to the Green Bay and Mississippi Canal Company, of the whole of that part of the south half of private claim No. 1 lying on the easterly side of the canal at Kaukauna aforesaid. The title of Martin so conveyed was in law determined to be an undivided half of the land conveyed by Mead and Law.

For history of this title see G. B. and M. Canal Co. *v.* Hewitt, volume 62, page 316.

The other undivided half of the land across which the canal runs passed, by mesne conveyances, from Law to Hewitt. (See 66 Wis., 461.)

The title to the undivided half was acquired by the Green Bay and Mississippi Canal Company after its transfer to the United States. This gives a good undivided half in the Government, with the other undivided half in Hewitt, to this land by paper title, but seizure by the public possession and presumptive title therefrom makes the title to the whole of the property safely in the United States. But it will be found, upon investigation of the location of the dam landing of the main Kaukauna dam, that it is not on this piece of land just described, but is on fractional section 24 north of the river, lying between private claim No. 1 and the river on two sides and section 23 on the third side. The title in the company to that part of section 24 on which the dam lands are is good and unquestioned, including also the west end of canal.

The canal then extends across private claim No. 1 and a long distance down the river, where the only title the Government have down the river below private claim No. 1 is on account of the taking and occupation for public use, being a title by limited presumption, and the same rule applies to both the other dams about the continuation of the canal along down.

RAPIDE CROCHE.

In the deed to the Green Bay and Mississippi Canal Company, under the head of No. 6, there occurs this description:

About 153.93 acres of land at Rapids Croche, being the south half of the northeast quarter in lots four (4) and five (5) in section number four (4), township number

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twenty-one (21), range nineteen (19) east, in the county of Outagamie and State of Wisconsin. For a more perfect description reference is had to a deed from Morgan L. Martin and wife to the president and directors of the Fox and Wisconsin Improvement Company, recorded in volume 9 of deeds, page 397, in the register of deeds office of Outagamie County.

Under this deed from Morgan L. Martin the canal company acquired and had title at the Croche to the north dam landing and the entire canal bed and locks.

In the same deed to the canal company occurs, under paragraph No. 7, the following description:

Two lots, to wit: One-half acre of land adjoining the lower lock in the canal at Kaukuana and one-half acre adjoining the lot next above the lower one aforesaid, which said lots are laid out in a square form in the county of Outagamie and State of Wisconsin.

Reference is made for a fuller description of the same to a deed from Morgan L. Martin to the president and directors of the Fox and Wisconsin Improvement Company, dated July 14, 1855, and recorded in the office of the register of deeds for said county, in volume 9 of deeds, on page 428.

The title to this land is in the United States, under the company.

LITTLE KAUKAUNA.

At Little Kaukauna, as will be seen by reference to a map of Jenne, engineer, accompanying this report, there was appropriated for the public work 7.85 acres of land, marked upon the map as lying between blue line and the original shore of the river.

I do not find anywhere any title, either in the Mississippi Canal Company, the Fox River Improvement Company, or the United States, upon record, covering this description of land. The land was unquestionably taken in the early days of the improvement, under the power conferred upon the Fox and Wisconsin Improvement Company by the State of Wisconsin.

There is an agreement with the Fox and Wisconsin Improvement Company and one Alfred Roe, in respect to the lands upon the other side of the river, in section 18, providing Roe was then the owner of the land upon that side, where the north landing of the dam at this point rests, whereby it was agreed by Roe that if the Fox and Wisconsin River Improvement Company would build a dam and locate the lock on his land, Roe would convey the lands covered by canal, dam, locks, and embankments of the improvement company free of charge, provided that the company should build and maintain a dam of sufficient height to give a sufficient flow for use for hydraulic purposes, the company to convey a half of the water power to Roe, and thereupon that Roe would convey to the Fox and Wisconsin Improvement Company sufficient land adjoining canal banks to enable them to make use of the other half of the water power reserved by them.

That agreement has been recognized in all transfers of this property, and the blue line on the canal company's map was traced and referred to in a plat of the land made by Clark, Emerson, and Boynton, subsequent owners, and all conveyances of any part of that land were made subject to this agreement, which is recited as bearing date October 14, 1856, until a conveyance of a part of the lots in 1887, when a new condition is interposed in the deeds of conveyance, attempting to avoid such agreement with the Fox and Wisconsin Improvement Company. I think that except the lands upon that side of the river where the dam rests, covered by this agreement, there can be no claim of title in the Government or the canal company, except a presumptive one.

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DEPERE.

The first provision made for a dam at Depere was by act of the legislative council of the Territory of Michigan in 1835, authorizing certain persons to build a dam and to make use of the water power. The persons so authorized were incorporated in the subsequent year. Nothing particular seems to have been done.

In 1849 the board of public works created under the laws of the State of Wisconsin asked for proposals for the construction of a dam and locks at this place for the Fox and Wisconsin River Improvement Company, a proposition for a brush and gravel dam and a timber lock. A section of the canal on the west side of the river was accepted, and on the east side of the river Joshua F. Cox made a proposition to construct the same, which was accepted, with the proviso that he would get a release from the former proposition upon the west side, and a surrender of the contract to the State. The dam was located by the chief engineer of the Fox and Wisconsin Improvement Company on the east side. A dam and lock of its kind was constructed under the proposition offered by Cox, and by an act of February 9, 1850, entitled "An act for the relief of Joshua F. Cox," the State of Wisconsin granted to him the free use of the surplus water for hydraulic purposes, created by the dam, or which should be hereafter created by reason of said dam, upon the condition that Cox should complete the work under his contract, and maintain forever the lock, dam, and canal, and should at all times pass boats through the lock free of charge.

Failure to perform was a forfeiture of right. There does not seem to have been anything in the form of a formal seizure and taking of lands to be used in the construction of said locks and canal and dam, and there does not seem to have been anywhere any description of what land was taken and used. It may be that, as to the old dam, a presumptive title can be maintained in the Government through the Fox and Wisconsin Improvement Company and its successor, the Green Bay and Mississippi Canal Company; but, unfortunately, after the assumption of the charge of the works by the United States, the location of the dam was changed, and, so far as I am able to ascertain, the money that was required to build a new dam and keep it in repair and construct a canal and a lock, commencing near 1878 and continuing up to 1896, was invested in this canal, dam, and locks, without any title at all by any seizure or any condemnation or pretense of seizure, and that the only memorandum of an agreement with reference to the same is upon a little scrap of paper, unsigned, I think, by anybody, wherein a note was made as between the engineer in charge and one Lawton, which leads to the opinion, from which I can not escape, that the Government has no title at all.

The lands that are described in paragraph 9 in the deed to the Fox and Wisconsin Improvement Company, containing 32.60 acres of land, in the county of Brown, known and described as lot 5, in section 18, township 22 north of range 20 east, as described in a certain deed from Morgan L. Martin and wife, dated July 10, 1855, and recorded in the office of the register of deeds for said Brown County in Volume S of deeds, page 168, to which said deed reference is made; and the further description of about 51.35 acres of land in the county of Brown, known as lot 4, in said section 18, referring for accuracy of description to a deed between the president and directors of the Fox and Wisconsin Improvement Company and the heirs and devisees of Robert Campbell, deceased, I have been unable to find any title of record.

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The land described in paragraph 11 of said deed as being a certain piece and lot of land at or near the village of Montello, in the county of Marquette, which was acquired and is now owned by the Fox and Wisconsin River Improvement Company and its trustees, I have accounted for by showing that the title thereto, except the title by presumption, is in N. M. Edwards, trustee for the present Green Bay and Mississippi Canal Company.

There are certain other rights that may properly be considered under this report, to wit: The rights of flowage, which have been acquired by the United States by payment and satisfaction of the awards and upon agreement. The number of the claimants was enormous and the claims extended on both shores of Lake Winnebago and upon all the tributaries to the lake.

Any payment of awards made by commissioners, and sums agreed to be paid, and paid by the representatives of the Government specially appointed for that purpose, I do not think can be relied upon as an absolute bar to any future claim for damages which may arise upon a new state of facts. It probably for years to come will prevent any further claims being made, *but in case of a change of the height of the dam at Menasha, which may pen up the water in Lake Winnebago higher than* it was at the time claimed for former damages so made, then in every case there will be a new claim arise, whether it is prosecuted or not.

I can not close this report without acknowledging the great obligations that I am under to the officers and attorney of the Green Bay and Mississippi Canal Company for their kindness in extending to me every opportunity and source of information in their power that would throw light upon any of the questions involved in the report, and also to Capt. George A. Zinn, of the Corps of Engineers, for maps and valuable information courteously furnished by him.

The time and examination required to cover the points made in this report have been much more extended than the reading of the act under which I was appointed would seem to indicate; but to the extent of my ability, and within the limits of the appropriation for the work, I have endeavored thoroughly and fully to discharge the duty reposed in me.

All of which is respectfully submitted.

EDW. S. BRAGG.

FEBRUARY 15, 1898.

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OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

The expenditures for maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams and lock houses, and for lock tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided for by section 4 of river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended hereto.

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The work during the fiscal year has consisted principally in dredging the channels of the river and canals and in making repairs of locks, dams, canal banks, lock houses, dredges, and boats.

For details of work done during the year see the report of Mr. L. M. Mann, assistant engineer, appended to this report. His report is accompanied by one tracing, hydrograph Lake Winnebago, discharge of Fox River, and rainfall, one blue print, general dredging data, and map of Stockbridge Harbor.

It is particularly to be noted that the continued enforcement of the rules and regulations for the navigation and use of the locks and canals on Fox River, approved by the Secretary of War, February 15, 1895, under the river and harbor act of August 17, 1894, has brought about a general condition which is far more satisfactory than ever before to all interests concerned.

Money statement.

July 1, 1897, balance unexpended	$7,774.50
Amount allotted for fiscal year ending June 30, 1898	60,009.62
	67,784.12
June 30, 1898, amount expended during fiscal year	62,597.03
July 1, 1898, balance unexpended	5,187.09
July 1, 1898, outstanding liabilities	1,959.43
July 1, 1898, balance available	3,227.66
Amount (estimated) for expenditure in fiscal year ending June 30, 1899	*63,869.10
Amount available for fiscal year ending June 30, 1899	67,096.76

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
FOX RIVER IMPROVEMENT,
Oshkosh, Wis., June 30, 1898.

CAPTAIN: I have the honor to submit the following report of operations upon "operating and care of canals and other works of navigation on Fox River, Wisconsin," from Portage to Greenbay, for the fiscal year ending June 30, 1898:

The work done during the year consisted principally in rebuilding the Kaukauna Fifth Lock and waste weir; backing Depere Lock with earth; building retaining wall at Depere Dam; repairing Little Kaukauna Dam; backing Rapide Croche and Little Chute dams and building needle houses for same; repairing Kaukauna First Lock and fencing United States property at this lock; repairing Kaukauna Dam; building a core wall at Little Chute First Lock; backing Cedars Dam; repairing Taintor gates of Appleton Lower Dam; building addition and repairing Appleton Third Lock house; repairing waste weir, Appleton Third Lock; repairing Appleton Second Lock; fencing United States property at Appleton First Lock; repairing Taintor gates of Appleton Upper Dam; repairing Menasha Lock and Eureka Lock; backing Eureka Dam; repairing Berlin Lock; building warehouse, timber shed, and repair shop at Berlin Lock; repairing White River Lock, Princeton Lock, and Grand River Lock; repairing Montello and Governor Bend dams; repairing Fort Winnebago Lock; repairing canal revetment of Portage Canal; repairs to boats and dredges; removing bars of Upper and Lower Fox River by dredging; and making incidental repairs to locks, dams, and canal banks, and incidental surveys.

MAINTENANCE OF NAVIGATION.

Navigation was closed formally November 23, 1897, on the Fox and Wolf rivers. The usual preparations for the winter, removing flushboards from the dams and drawing the water from the Little Chute and Kaukauna canal systems, were made. Navigation was again opened April 8, 1898, on the Upper Fox and Wolf, and April 12, 1898, on the Lower Fox River.

The water in the Lower Fox and Lake Winnebago has been well maintained at the crest of the dams throughout the year with few exceptions, or when it was allowed

*Amount allotted if estimate is approved.

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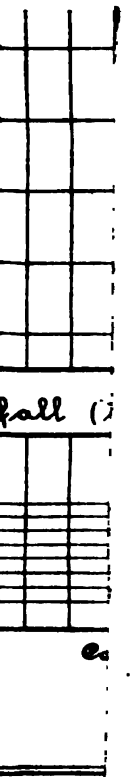

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to be drawn from Lake Winnebago by special permission of the Secretary of War. The enforcement of Rule 12 continues to have its good effect, and the troubles of previous years have passed. The conditions respecting the water are far better than ever before, and all interests express great satisfaction. Navigation is undoubtedly improving and water users have more power with the same quantity used.

The stages of Lake Winnebago are shown on hydrograph accompanying this report, with discharge as observed at Rapide Croche Dam and precipitation of the upper valleys. Hydrograph shows:

Water below crest of dam	days..	182
Water above crest of dam	do...	183
Maximum height of water May 4, 1898	feet..	3.04
Maximum height of water April 17, 1897	do...	3.03
Lowest point reached March 1, 1898	feet below crest..	0.81
Lowest point reached August 26, 1897	do...	0.70

Of the one hundred and eighty-two days below crest, water was less than one-tenth foot below crest during thirty-one days.

Maximum discharge of river measured at Little Kaukauna Dam was 430,740 cubic feet per minute on May 6, 1898.

Mean monthly discharges at Rapide Croche, which corresponds nearly to the discharges at Neenah and Menasha, for the year are as follows:

1897.	Cubic feet per minute.	1898.	Cubic feet per minute.
July	192,001	January	153,505
August	110,932	February	141,575
September	49,757	March	178,238
October	85,525	April	244,656
November	111,233	May	284,740
December	133,010	June	194,168
		Mean for year	156,612

In continuance of the history of the water regulation, I would state that the water in Lake Winnebago commenced dropping below the crest of Menasha Dam during last ten days of August and first ten days of September, 1897, and then stood at the crest until the beginning of November. During this time the mills at Menasha shut down promptly from August 19 to September 13, while at Neenah they did not stop drawing water until August 27; all the latter parties were arrested for violation of the law. On October 8, 1897, the Secretary of War permitted the mills to draw the water 6 inches below the crest. The mill men used this privilege sparingly and the water did not go below the crest until November 2, and then it fell gradually. On January 12, 1898, the Secretary of War gave further permission to draw the water 18 inches below the crest until the opening of navigation. The water reached its lowest point March 1, 1898, at about 10 inches below the crest and at the crest on March 23, fifteen days before the opening of navigation. The maximum was the same as last year, 3.04 feet, but was reached in May, a month later than last year. The mean discharge was slightly greater than last year, as given above. Limited sluicing at Menasha was only required from May 3 to 16 to keep the lake down, but this should be divided between Neenah and Menasha, so as to cause as little backwater to the mills as possible and treat all alike.

Maintaining the water at the crests of dams has undoubtedly increased the traffic on the Lower Fox, as shown by largely increased lockages, tonnage, and passenger travel, and I believe it will continue to increase.

In September, 1897, a new traffic was commenced by carrying lumber from Menominee, Mich., to Oshkosh, Wis., on barges. A regular line has been established and continued, reducing railroad rates more than one-half. A contract has been made to continue this traffic all this season.

For marking channel two cribs, 10 by 10 by 9 feet, were constructed and placed on left channel line below Menasha Lock, and one crib, 16 by 16 by 11 feet, was constructed and placed at the left of entrance to Menasha River, on Lake Winnebago. These cribs were placed and completed July 30, 1897, and this spring the entrance crib and the lower one below the lock were furnished with post lights by the Light-House Department, which already have given great satisfaction. The cribs were built according to new plan to resist the action of the ice. All previous cribs have been destroyed or overturned. These stood the test last winter and spring. They are built square to low water and then topped off with oak plank, running almost to a point, offering little resistance to the ice. Buoys and other cribs for marking channels and reefs were set.

All gauge readings were calculated, tabulated, and platted, as were also daily

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discharges of the river at different points. A new general map of the Fox River, on a scale of 3 inches to the mile, has been commenced and about one-third completed. A general profile of the Fox River from Portage to Greenbay, horizontal scale of 1 inch to 6,000 feet and a vertical scale of 1 inch to 10 feet, showing detail, has been completed in portfolio form.

A complete tabulation of the water powers on the Lower Fox is respectfully referred to in the Annual Report of the Chief of Engineers for 1897, page 2722.

REPAIRS OF LOCKS, ETC.

Depere Lock.—Right and left lock walls and upper left-wing wall were backed, and left canal bank above lock was leveled up, under agreement with Thiele & Handeyside, of Depere, 1,057 cubic yards of clay being used.

Depere Dam.—The retaining wall below right abutment, commenced in May, 1897, was completed and backed during June, and the seams of left abutment were repointed.

Little Kaukauna Lock.—Upper revetments were each protected with two guard piles, driven under agreement with Adolph Green, of Greenbay.

Little Kaukauna Dam.—The submerged apron cribs below dam were refilled where stone had washed out and were decked over, using 21,550 feet B. M. of timber and 47 cords of stone. Sluiceway and walk were protected with 22 guard piles, driven under agreement with Adolph Green, of Greenbay, and new needles, 220 in all, were purchased.

Rapide Croche Dam.—A needle house was built at Appleton and placed at left abutment. The dam was backed in November by dredge No. 2, 2,551 cubic yards of clay being used.

Kaukauna Fifth Lock.—This lock, composed of dry rubble masonry, faced with plank, was built in 1854, and has since been repaired at different times. It was entirely rebuilt this season, the same style of construction being used, with following improvements: Lock was lengthened upstream to standard length, 170 feet; valve platform was constructed at upper end and valves removed from upper gates; two horizontal girts instead of one were used in wall construction to facilitate repairs above water; mud sill was bolted to solid rock and backed with concrete; head walls are of cut stone and laid in cement, and left wall has a spur running into bank to prevent leakage around lock wall; old gate maneuvering gear was replaced by standard tripod system, with a newly designed steel spar fastened to side of gate and running under the coping of wall; wooden hand rails were replaced by gas pipe. The walls are built on rock, and formed with 8 by 10 inch oak posts 4 feet apart, faced with two thicknesses of 2-inch dressed pine plank and backed with dry rubble. The posts are mortised into mud sills and tied back with iron rods, and two girt courses of 10 by 12 inch oak are placed equal distances from bottom of coping and top of mud sill. The coping, 6 feet wide, is of two parallel timbers, 10 by 16 inch front and 10 by 10 inch back, with cross ties, the spaces being filled in with stone and surfaced with concrete. Hollow quoins are oak posts, and head and tail walls are of cement masonry. General dimensions are: Length over all, 227½ feet; between hollow quoins, 170 feet; top width of chamber, 35.6 feet; height of walls average 21 feet; lift, 10.2 feet. The coping is about 4 feet above water surface of canal. The old lock was 160½ feet between hollow quoins. The upper quoins, with breast wall and upper miter sill, were thus moved 9½ feet upstream.

Rebuilding lock walls.—Work was commenced at close of navigation, November 22. A plank dam, backed with earth, was built across canal above lock, and across lower entrance a dike was thrown up by dredge No. 2. Lock was pumped out, earth removed from behind walls, old timber torn out, and all walls taken down to about 8 feet above floor. Mud sills were set in cement and bolted to rock; posts, girts, tie-rods, etc., were set up, the rods being bedded in cement masonry; dry masonry was laid in walls, quoins and coping timbers fitted, and walls planked. Where advisable, backing of quoins and of recess walls was laid with cement.

Masonry.—Breast wall and upper and lower wing walls and miter sills were removed, and new walls commenced after making required excavation. Tail walls were made of cement rubble for about 8 feet above their base, and of dry rubble above, while lower wing walls were laid dry. Breast walls and head and upper wing walls were made of cement rubble, the two latter being faced with cut stone. Coping stones of head wall were doweled to prevent being knocked off by boats. All mortar was composed of 1 part of Louisville cement to 3 parts of sand, and stone used was taken from old work or from a seam quarried below lower miter sill. Between tail walls a sill was bolted and braced to the solid rock and niches cut in the wall for placing a temporary cofferdam during repairs.

On left canal bank, above lock, a retaining wall of dry rubble was built, 100 feet long, commencing at end of wing wall.

Gates, valves, etc.—Lower gates were rebuilt and each provided with three butterfly valves; the old gates had only two. The timbers are bolted together from top to bottom with 1¼-inch tie-rods 17 feet long. Upper gates were also rebuilt, chiefly

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with old material, and wooden hand rails were replaced in all cases with new ones of gas pipe. Tops of quoin, heel and toe posts were bored and oiled and covered with metal caps. The valves were omitted in the upper gates and a substitution made of six butterfly valves, worked by gearing on the coping. These were placed in a horizontal timber platform just above the upper miter sill, under which the discharge flows. The sill and platform were supported in center by a masonry pier and at other points, to offer a minimum obstruction to flow of water, by 36 posts of 2½-inch gas pipe screwed into cast-iron sockets. An anchorage of 1½-inch iron rods, secured to eyebolts in rock, was placed on each side of center pier to prevent distortion of platform. The capstan-and-rope system of opening gates was replaced by standard tripod system, but using spars of steel channels, newly designed, instead of timber ones. The old wooden snubbing posts were put back in place.

The following is a summary of quantities:

Earth dredged in placing and removing dams	cubic yards..	5,223
Earth-wheeled in placing same	do....	670
Earth excavated for new construction	do....	2,174
Old timber removed	feet B. M..	61,026
Dry rubble removed from walls	cords..	639
Oak timber in new walls, etc	feet B. M..	35,012
Pine timber in new walls, etc	do....	57,392
Timber in upper gates	do....	3,954
Timber in lower gates	do....	11,270
Dry rubble laid in walls	cubic yards..	1,686
Cement masonry in walls	do....	590
Filling and grading	do....	450
Cement used (Louisville)	barrels..	500

Kaukauna Fifth Lock House.—Grading and minor repairs were made during the year.

Waste weir at Kaukauna Fifth Lock.—The old wooden waste weir was replaced with one of cement masonry founded on rock, connected to upper end of right lock wall with a retaining wall, and protected above with a core wall along canal bank. Work was begun in February and completed in April, 1898. The spillway is 22 feet long, with the wall 16 feet 10 inches high and 3 to 5 feet thick. Total masonry laid 309 cubic yards.

Kaukauna Third Lock.—Left upper gate hangings were repaired.

Kaukauna First Lock.—Wooden bulkhead of upper valve recess was rebuilt and valve machinery refitted.

Kaukauna First Lock House.—Sewer pipe was replaced and a new woven-wire fence about 18½ rods in length placed around lock-house property on the "blue" or boundary line.

Kaukauna Dam.—Stringers and plank of upper apron were replaced to the amount of 19,533 feet B. M.

Little Chute First Lock, retaining wall.—A wall of cement masonry, founded on rock, was built from head of lock to stone flume of Verstegen flouring mill to stop seepage through embankment. As the foundation was seamy and full of leaks, a frame was placed over it and filled with 2 feet of concrete, on which the stonework was built. Construction was finished in August, 1897, the wall containing 117 cubic yards.

Little Chute Dam.—A needle house was built at Appleton and placed near left abutment. The dam was backed in October by dredge No. 2, 1,837 cubic yards of clay and gravel being placed.

Cedars Lock.—Minor repairs were made to woodwork of lower gates.

Cedars Dam.—The dam was backed in October by dredge No. 2, 1,220 cubic yards of clay being placed.

Appleton Fourth Lock.—A broken gate spar was replaced.

Appleton Lower Dam.—New truss beams, trunnions, and saddle blocks were fitted to the 5 Taintor sluice gates.

Appleton Third Lock House.—A second story was added, providing two additional rooms, and sundry repairs made.

Waste weir above Appleton Third Lock.—Upper and lower wooden aprons and the walk were rebuilt.

Appleton Second Lock.—Six automatic iron valves were placed in face of chamber walls to permit escape of any water collected behind them. These walls commenced to bulge outward some years ago, owing to poor quality of masonry. Six new iron snubbing posts were set and minor repairs made.

Appleton First Lock.—A woven-wire fence was placed on the boundaries of United States property on south side of canal, 2,175 feet long.

Appleton Upper Dam.—Truss beams and saddle blocks were replaced in third and fourth sluice gates and minor repairs made to second and first gates.

Menasha Lock.—Upper right wing crib was repaired, three new gate spars put in,

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and minor repairs made. The deck of channel crib below lock was leveled up. (See also Maintenance of navigation.)

Eureka Lock.—Six new iron snubbing posts were set, the walls pointed where required, two top courses reset on lower wing walls, and minor repairs made.

Eureka Dam.—Depressions in backing, due to undermining of sand foundation, were filled up.

Berlin Lock.—Six new iron snubbing posts were set, four new tripods and fittings put up, walls repointed, and minor repairs made.

Warehouse at Berlin Lock.—A warehouse was built close to lock, 24 feet by 48 feet, founded on masonry piers, and similar to the one at Appleton. Work was begun October 27 on grading site, and building completed December 13. Lumber used, about 19,600 feet B. M.

Timber shed at Berlin Lock.—A timber shed was built below lock of design identical with the one at Appleton, 24 feet by 48 feet, with posts set up in concrete, and the natural earth as floor. The site was graded with 774 cubic yards of earth, and the construction was finished December 4. Lumber used, 7,152 feet B. M.

Repair shop at Berlin Lock.—The old warehouse was moved near to the timber shed, set up on piers, and fitted with a forge, drill press, vises, etc., for use in repairing tools and machinery. These proved of great advantage in repairing boats and dredges this spring.

Scrap-iron shed at Berlin Lock.—This shed, measuring 20 feet by 30 feet, was built in December from surplus lumber, and is used for storing old material.

White River Lock.—Six new iron snubbing posts were set and walls were repointed. New lower wing walls were built of cut stone on timber cribs, being completed in May. They are about 18 feet long, the upper end being level with coping of lock.

Princeton Lock.—Six new iron snubbing posts were placed, lock walls repointed, and minor repairs made. New lower wing walls were built of cement masonry on timber cribs, the sites having been excavated by dredge No. 7. They were begun in August and completed in October, 1897. Two protection piles were driven at each lower end:

The quantities were:

Earth excavation and filling	cubic yards..	979
Timber in cribs	feet B. M..	13,265
Riprap in cribs	cords..	9¾
Driftbolts, etc	lbs..	764
Cut stone	cubic yards..	30
Cement, Louisville	barrels..	15

Grand River Lock.—Six new iron snubbing posts were set, lock walls repointed, and new tripod system put in, and minor repairs made. Upper and lower timber wing wall cribs were rebuilt, using 26¼ cords of riprap and 20,100 feet B. M. of timber, the latter taken from material intended for use on Portage Canal.

Montello Dam.—The old waste weir next left abutment was closed up with a timber crib. There were used 6¼ cords of stone filling and 5,100 feet B. M. of pine, the latter being taken from material purchased for Portage Canal.

Governor Bend Dam.—The old crib abutments were replaced with new timber cribs filled with stone; 20 cords of riprap were required and 12,176 feet B. M. of pine, taken from material for Portage Canal. The crest of dam was leveled up to its original height.

Fort Winnebago Lock.—Upper timbers of upper wing revetments were replaced; lower wing wall cribs above water line were rebuilt and filled with stone, and minor repairs were made. Total material used, 10,708 feet B. M. of pine and 11 cords of stone.

Portage Canal Revetment.—Work was begun in July, 1897, near Fort Winnebago Lock, on repairing timber revetments which line the banks of canal. The earth pressure had displaced and bowed the upper timbers; these were straightened, renewed where required, fastened in place, and tied back to anchor piles with iron rods. Over 140 muskrat holes were found and stopped up. Work on left revetment was completed to 390 feet above upper railroad bridge, or more than half the length of canal, and on right revetment to 190 feet above same point, and was partly finished to 650 feet and 450 feet above the bridge on left and right sides, respectively. Legal complications with property owners claiming land up to bank of canal suspended further progress early in August, and work was finally abandoned on August 16, and has not been resumed since.

Old timber removed	feet B. M..	83,636
Driftbolts removed	number..	1,575
Earth excavated	cubic yards..	556
New timber put in	feet B. M..	76,486
Anchor rods put in	number..	388
Timber received for repairs	feet B. M..	242,887

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REPAIRS OF BOATS AND DREDGES.

Steam tug Fox.—This boat was laid up at Berlin on December 2. In April, 1898, sundry repairs were made to hull and upper works, and all parts were cleaned and painted. She went into commission April 18.

Steam tug Boscobel.—This boat was laid up on November 23 in the canal level below Kaukauna Second Lock. In March she was blocked up, hull and paddle wheels and other parts repaired, seams calked, and hull painted. She was put into commission April 13.

Steam tug General G. K. Warren.—This boat went out of commission on November 30, and lay all winter just below Kaukauna Fifth Lock. In April she was towed by the *Boscobel* to Appleton First Lock, where she will lie, moored, until required.

Dredge No. 2.—This dredge was laid up on December 2 just below Kaukauna Fifth Lock. A new dipper handle was framed and put on and minor repairs made. She went into commission April 11.

Dredge No. 4.—(See also improvement report.) This dredge was laid up at Berlin Lock on November 26. In April the dipper and its fittings, the hull, and the deck were repaired, seams calked, two oak spuds framed, and hull painted. She went into commission April 28.

Dredge No. 5.—This dredge was laid up at Berlin Lock on November 23. Minor repairs were made to dipper and to deck, seams calked, and cabin floor and other parts painted. A 16-foot skiff was built. She went into commission April 25.

Minor repairs were made to dredge No. 7, 50-foot wood scows Nos. 4, 5, and 7, 80-foot scows Nos. 1 and 2, dump scows Nos. 3 and 4, quarter boat No. 1, and 90-foot scow.

SURVEYS.

A line of levels was run between Menasha and Eureka locks, 34 miles, to establish a connection between the elevations used on the lower and upper rivers. The same datum is now used throughout, viz, top of abutment of Appleton upper dam, assumed at 250 feet.

On March 23, 1898, the zero of the Oshkosh gauge was raised to the same elevation as that of Deuchman's gauge at Menasha, or to 253.515 feet. The crest of Menasha Dam now corresponds to the reading of 1.730 feet on each gauge, this being the legal elevation of the crest as determined by the courts.

Surveys and maps were also made of United States property at Kaukauna First and Fifth locks, where the "blue line" or property line was marked out; of land at Shipleys Island, below White River Lock, and of property at Berlin Lock. All corners were marked with iron bolts.

Soundings were taken on the ice in January and February from Depere to Kaukauna Guard Lock, and from Combined locks to Cedars Lock, for the purpose of obtaining reliable maps of the channel. The boring machine referred to in the report for 1897 was used where practicable, and supplemented by measurements from skiffs and by the use of a level in the dry canals. Soundings were taken 100 feet apart in the main river on the transit line and 20 feet to 50 feet apart on the cross lines for a channel width of 200 feet. In the canals they were made 50 feet to 100 feet apart on the transit line and 10 feet to 20 feet apart on the cross lines, and all results were subsequently platted.

A line of soundings was taken in November along center of sailing line from Oshkosh to Cedars, and the river sounded in August with the steam tug *Boscobel* from Port Hope Bridge to Portage, about 8 miles.

This work supplements existing data, and a complete profile of the Fox River from Portage to Greenbay has thus been placed on record.

CARE OF WORKS AND PROPERTY.

Unserviceable property was collected and stored at Appleton; signboards against trespassing were placed; grass seed distributed to the lock tenders; buildings painted, etc. Condemned dredges Nos. 4 and 5, with seven scows and three skiffs, were dismantled and broken up at Berlin Lock for firewood.

DREDGING LOWER FOX.

This work was carried on by dredge No 2, attended by steam tug *General G. K. Warren.*

Channel between Appleton Second and Fourth locks.—This was cleared out in October, 1897, when 278 cubic yards of gravel, in addition to some snags and loose rock, were removed.

Channel below Menasha Lock.—This was widened and cleared, 9,321 cubic yards of clay and loose stone being removed and dumped on the channel banks or with dump scows.

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DREDGING UPPER FOX.

Dredging was carried on for providing a navigable channel 100 feet wide and 6 feet deep at mean low water. Dredges Nos. 4 and 5, attended by steam tugs *Fox* and *Boscobel*, were engaged continuously upon the work till the close of navigation, except during September and October, 1897, when dredge No. 5 was employed upon Wolf River. Dredge No. 7 was also employed for a short time at various places in dredging the regular channel when not employed at the construction of Princeton and Grand River dams. (See improvement report.) They commenced again at the end of April, 1898, and were assisted later by dredge No. 2.

The 6-foot channel was completed from Berlin Lock to about 5½ miles below Eureka Lock, or about 14 miles in all, excepting a few points below Berlin between section posts 28 and 30 and 23 and 25, that had been left last year and had to be deepened. Several bars were dredged at points above Berlin.

The following is a summary of work done (see also table of cost of dredging):

Between old mileposts.	Summary of cuts.			Total handled (dipper measurement).
	Length.	Width.	Average depth.	
	Feet.	*Feet.*	*Feet.*	*Cu. yds.*
Grand River lock and 72	3,210	20–40	½–10	8,077
Lake Apuckawa	360	40	2 – 3	1,434
53–52	4,293	25–45	1½ – 8½	20,504
48–47	185	35	3	646
White River dam				646
Below White River lock	140	40	2 – 6	617
36–35	147	35	1½	355
At Berlin lock				2,366
30–29	3,200	20–75	½– 6	12,883
29–28	4,650	40–60	½– 3	13,578
28–27	960	45–60	½– 2	2,403
27–26	250	30	1½	450
26–25	3,330	30–40	1 – 4	15,455
25–24	9,685	18–65	1½– 6	53,846
24–23	9,900	8–40	1½– 8	35,210
23–22	5,800	20–40	1½– 4	17,122
22–21	7,700	10–75	½– 2	27,527
21–20	11,625	10–35	½–10	35,652
20–19	6,575	10–35	½– 9	15,880
Total				264,135

Between old mileposts.	Total rehandled (dipper measurement).	Material.	Remarks.
	Cu. yds.		
Grand River lock and 72	1,312	Sand	By dredge No. 7, when not working at Grand River dam.
Lake Apuckawa		do	By dredge No. 7.
53–52	4,858	do	Do.
48–47		do	Do.
White River dam		do	By dredge No. 7, for filling behind protections.
Below White River lock		do	By dredge No. 7.
36–35		Loose stone	Do.
At Berlin lock	802	Sand	By dredge No. 7, for grading.
30–29	390	Sand, clay, and stone	By dredges Nos. 4 and 5.
29–28		Sand and clay	By dredge No. 5.
28–27		Sand	Do.
27–26		do	By dredge No. 4.
26–25	4,676	do	Do.
25–24	15,846	Sand and clay	By dredges Nos. 4 and 5.
24–23	12,374	do	Do.
23–22	1,476	do	By dredge No. 4.
22–21	8,671	do	By dredges Nos. 4 and 5.
21–20	10,207	Sand, clay, and gravel	By dredges Nos. 2 and 4.
20–19	3,545	Sand and clay	Do.
Total	64,157		

Respectfully submitted.

L. M. MANN, *Assistant Engineer.*

Capt. GEO. A. ZINN,
Corps of Engineers, U. S. A.

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Data respecting dredging done on Fox and Wolf rivers, Wisconsin, for the year 1897 (calendar).

Dredge.	Location of dredging.	Material handled. a	Material rehandled. a	Material scowed. a	Per cent of material rehandled.	Depth of material dredged.	Character of material dredged.	Days employed.	Hours worked.	Hours lost.	Cost of running repairs.
		Cu. yds.	*Cu. yds.*	*Cu. yds.*							
No. 2...	Lower Fox *b*	17,052	1,275	7,400	74.77	3″ to 9′	Clay, gravel, stone, and hardpan.	71	392	96	.....
No. 2...	Stockbridge Harbor. *c*	39,351	6,962	30,103	17.70	1′ to 12′	Quicksand and as next above.	100	607	89	$27.21
No. 4...	Upper Fox *d*	117,872	27,486	.....	23.32	1′ to 6′	Sand and clay.	207	1,333	91	48.09
No. 5...	Wolf *e*	22,722	.....	.....	.....	1′ to 5′	.....do.....	58	366	26	25.05
No. 5...	Upper Fox *d*	70,962	27,247	.....	38.40	1′ to 8′	Sand, clay, and stone.	147	937	79	.35
No. 7...	Upper Fox *d*	41,411	13,837	.....	32.21	1.5′ to 8.5′	Sand, clay, gravel, stone, and hardpan.	74½	453	63	.77
	Total.	309,370	76,813	37,503	24.67	.....	.....	657½	4,088	444	101.47

Dredge.	Location of dredging.	Cost of general repairs.	Cost of fuel.	Cost of sundries.	Cost of crew.	Cost of towing.	Cost of superintendence.	Total cost.	Material handled per day of eight hours. a
									Cu. yds.
No. 2...	Lower Fox *b*	$183.60	$180.68	$12.07	$828.33	$383.55	$180.00	$1,768.23	348
No. 2...	Stockbridge Harbor. *c*	258.59	324.52	17.02	1,166.67	1,182.42	36.50	3,012.93	518.6
No. 4...	Upper Fox *d*	1,251.00	928.97	31.50	2,449.50	172.29	138.03	5,019.38	707.4
No. 5...	Wolf *e*	105.50	79.15	10.83	*e* 570.33	*f* 254.59	.....	1,045.45	496.7
No. 5...	Upper Fox *d*	258.47	383.48	27.43	1,445.50	200.18	78.50	2,393.91	605.9
No. 7...	Upper Fox *d*	1,262.02	389.27	15.36	846.08	236.78	35.01	2,785.29	731.3
	Total..	3,319.18	2,286.07	114.21	7,306.41	2,429.81	468.04	16,025.19	605.4

Dredge.	Location of dredging.	Cost per cubic yard.						
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.
No. 2...	Lower Fox *b*	$0.0000	$0.0108	$0.0106	$0.0007	$0.0485	$0.0225	$0.0105	$0.1036
No. 2...	Stockbridge Harbor. *c*	.0007	.0066	.0083	.0004	.0297	.0300	.0009	.0766
No. 4...	Upper Fox *d*	.0004	.0106	.0079	.0003	.0207	.0015	.0012	.0426
No. 5...	Wolf *e*	.0011	.0046	.0035	.0005	.0251	.0112	.0000	.0460
No. 5...	Upper Fox *d*	.0000	.0036	.0054	.0004	.0204	.0028	.0011	.0337
No. 7...	Upper Fox *d*	.0000	.0305	.0094	.0004	.0204	.0057	.0009	.0673
	Averages.	.0003	.0107	.0074	.0004	.0236	.0079	.0015	.0518

a Dipper measurement.
b Appropriation for improvement, operating, and care.
c Appropriation for improvement.
d Appropriation for operating and care.
e The cost of removing 1,235 snags and 26 piles by dredge No. 5 is included in "cost of crew."
f The cost of removing 481 snags, 28 piles, and 277 overhanging trees by the steam tug Boscobel is $482.83, not included in the above tables.

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The following table is not included in the above, being work otherwise than regular dredging (see footnote):

Dredge.	Location of dredging.	Material handled.	Material rehandled.	Material scowed.	Per cent of material rehandled.	Depth of material dredged.	Character of material dredged.	Days employed.	Hours worked.	Hours lost.	Cost of running repairs
		Cu. yds.	*Cu. yds.*	*Cu. yds.*		*Feet.*					
No. 2...	(a d)	5,328	1,208	2,322	22.67	1 to 14	Clay, gravel, and stone.	17	81	31	.....
No. 2...	(b d)	6,163	964	4,977	15.63	2 to 4	.....do.....	26	116	60	.....
No. 7...	(c e)	36,210	5,479	8,006	15.13	1 to 14	Sand, clay, and stone.	78½	482	46	$4.25
	Total..	47,701	7,651	15,305	16.04	.....	.....	121½	679	137	4.25

Dredge.	Location of dredging.	Cost of general repairs.	Cost of fuel.	Cost of sundries.	Cost of crew.	Cost of towing.	Cost of superintendence.	Total cost.	Material handled per day of eight hours.
									Cu. yds.
No. 2...	(a)	$43.96	$33.10	$2.89	$198.33	$96.90	$42.19	$417.37	528.2
No. 2...	(b)	67.23	66.09	4.42	303.33	307.90	75.00	823.97	425
No. 7...	(c)	1,329.72	374.92	16.19	964.41	376.74	80.87	3,147.10	661
	Total..	1,440.91	474.11	23.50	1,466.07	781.54	198.06	4,388.44	562.2

Dredge.	Location of dredging.	Cost per cubic yard.						
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.
No. 2...	(a)	.....	$0.0082	$0.0062	$0.0005	$0.0374	$0.0181	$0.0079	$0.0783
No. 2...	(b)	.....	.0109	.0107	.0007	.0492	.0500	.0122	.1337
No. 7...	(c)	$0.0001	.0367	.0104	.0005	.0266	.0104	.0022	.0869
	Averages.	.0001	.0302	.0099	.0005	.0308	.0164	.0041	.0920

a Work consisted of removing earth dam below De Pere lock and building earth dam below Kaukauna fifth lock.

b Work consisted of backing Rapide Croche, Little Chute, and Cedars dams; also leveling foundations for three cribs at Menasha and removing old crib and obstructions at head of Neenah Channel.

c Work consisted of dredging for new dam and for new lower wing walls of lock at Princeton and for filling behind shore protections at White River dam. Dredge was also employed in driving sheet and round piles and assisted in sinking dam and constructing abutments of Princeton dam.

d Appropriation for operating and care.

e Appropriation for improvement, operating, and care.

NOTE.—Dredging began April 14, 1897, and was suspended November 29, 1897.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION APPLIED TO FOX RIVER, WISCONSIN, SECTION 4 OF RIVER AND HARBOR ACT OF JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1898, with itemized statement of expenses attached as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of De Pere lock	Materials	$338.99	
Do	Labor	25.00	
			$363.99
Repairs of De Pere dam	.....do	.....	61.93
Repairs of Little Kaukauna lock	Materials	.....	6.00
Repairs of Little Kaukauna dam	.....do	949.09	
Do	Labor	241.67	
			1,190.76

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Detailed statement of expenditures for fiscal year ending June 30, 1898, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Rapide Croche dam	Materials	$68.79	
Do	Labor	254.02	
			$322.81
Repairs of wasteweir above Kaukauna fifth lock.	Materials	466.95	
Do	Labor	1,063.94	
			1,530.89
Repairs of Kaukauna fifth lock	Materials	4,885.67	
Do	Labor	7,984.56	
			12,870.23
Repairs of lock house, Kaukauna fifth lock.	Materials		2.49
Repairs of Kaukauna third lock	Labor		8.00
Repairs of lock house, Kaukauna second lock.	Materials		5.40
Repairs of wasteweir above Kaukauna first lock.	.....do		182.64
Repairs of Kaukauna first lock	.....do	33.36	
Do	Labor	214.50	
			247.86
Fence at Kaukauna first lock	Materials		21.57
Repairs of lock house, Kaukauna first lock.	.....do		12.40
Repairs of Kaukauna guard lock	.....do		.60
Repairs of Kaukauna dam	.....do	433.32	
Do	Labor	199.62	
			632.94
Repairs of Little Chute second lock	.... do		11.00
Repairs of cross wall at Little Chute first lock.	Materials	136.30	
Do	Labor and transportation	589.17	
			725.47
Repairs of Little Chute dam	Materials	68.78	
Do	Labor	146.53	
			215.31
Repairs of Cedars lock	Materials	34.79	
Do	Labor	56.75	
			91.54
Repairs of Cedars dam	Materials	47.69	
Do	Labor	122.66	
			170.35
Repairs of Appleton fourth lock	.....do		85.80
Repairs of wasteweir above Appleton third lock.	.....do		54.37
Repairs of Appleton third lock	.....do		5.63
Repairs of lock house, Appleton third lock.	Materials	93.75	
Do	Labor	131.80	
			225.55
Repairs of Appleton second lock	Materials	66.15	
Do	Labor	140.87	
			207.02
Repairs of Appleton first lock	.....do		10.25
Fence at Appleton first lock	Materials	11.68	
Do	Labor	82.81	
			94.49
Repairs of Appleton upper dam	Materials	42.21	
Do	Labor and transportation	166.28	
			208.49
Repairs of Appleton lower dam	Materials	280.29	
Do	Labor	507.95	
			788.24
Repairs of Menasha lock	Materials	4.99	
Do	Labor	126.39	
			131.38
Repairs of Menasha dam	Materials		3.10
Repairs of Stockbridge Harbor	Stone for shore protection		20.60
Repairs of Eureka lock	Materials	43.27	
Do	Labor	61.83	
			105.10
Repairs of roadway at Eureka lock	.....do		67.51
Repairs of Eureka dam	Materials	5.18	
Do	Labor and transportation	11.67	
			16.85
Repairs of Berlin lock	Materials	231.73	
Do	Labor	134.04	
			365.77
Repairs of lock house, Berlin lock	Materials	4.40	
Do	Labor	6.25	
			10.65

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Detailed statement of expenditures for fiscal year ending June 30, 1898, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of warehouse, Berlin lock	Materials	$898.86	
Do	Labor	923.91	
			$1,822.77
Repairs of shore protection above White River lock.	Materials		122.91
Repairs of White River lock	....do	253.73	
Do	Labor	568.99	
			822.72
Shore protection below White River dam	....do		6.13
Repairs of Princeton lock	Materials	260.88	
Do	Labor and transportation	466.60	
			727.48
Repairs of Grand River lock	Materials	407.69	
Do	Labor	289.63	
			697.32
Repairs of Montello dam	Materials	45.21	
Do	Labor	64.13	
			109.34
Repairs of Governor Bend lock	Materials		.50
Repairs of Governor Bend dam	do	70.38	
Do	Labor and transportation	222.52	
			292.90
Repairs of Fort Winnebago lock	Materials	121.50	
Do	Labor	53.95	
			175.45
Repairs of Portage Canal	Materials	4,346.63	
Do	Labor	944.56	
			5,291.19
Sounding Lower Fox River	Materials	1.40	
Do	Labor	363.08	
			364.48
General repairs of locks, dams, and canal banks.	Materials	517.45	
Do	Labor	4,613.60	
			5,131.05
Dredging bars, Lower Fox	Fuel, supplies, etc	2.30	
Do	Labor	507.38	
			509.68
Dredging bars, Upper Fox	Fuel, supplies, etc	2,300.58	
Do	Labor	6,291.23	
			8,591.81
Repairs of boats and dredges	Rent of boat yard at Oshkosh	100.00	
Do	Repairs of dredge No. 2	127.19	
Do	Repairs of dredge No. 4	241.95	
Do	Repairs of dredge No. 5	133.05	
Do	Repairs of dredge No. 7	330.55	
Do	Repairs of steamer Fox	319.11	
Do	Repairs of steamer Boscobel	440.68	
Do	Repairs of steamer Gen. G. K. Warren.	10.92	
Do	Repairs of barge Princeton	16.44	
Do	Repairs of quarter boat	144.27	
Do	Repairs of pile driver	35.00	
Do	Repairs of scows	1,204.20	
			3,103.36
Maintenance of navigation	Lock-tenders' services	7,020.00	
Do	Gauge-keepers' services	180.00	
Do	Watchmen, labor, etc	1,147.96	
Do	Platting gauge readings, discharges, etc.	223.85	
Do	Cribs to mark channel at Menasha	170.98	
			8,742.79
Care of works and property	Watchmen, labor, and transportation	996.17	
Do	Traveling expenses of assistant engineers, overseers, etc.	518.93	
			1,515.10
Contingencies	Salaries of assistant engineers, clerks, etc.	2,725.00	
Do	Rent of office at Oshkosh, Wis	300.00	
Do	Rent of office at Milwaukee, Wis	75.00	
Do	Mileage	70.34	
Do	Stationery	370.38	
Do	Rent of telephone, etc	140.70	
Do	Rent of post-office box at Oshkosh, Wis.	3.00	
Do	Desk for office at Oshkosh, Wis	20.00	
Do	Ice for office	5.00	
			3,709.42
Total			62,597.03

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
July 2	1	Hired men	Services, June, 1897	$2,687.12
Aug. 2	1	L. M. Mann	....do	200.00
2	2	John M. Paige	....do	35.00
2	3	Alexander Sims	....do	35.00
2	4	John Baeten	....do	25.00
2	5	George T. Allanson	....do	30.00
2	6	George Gifford	....do	25.00
2	7	John A. Banker	....do	25.00
2	8	Gabriel Wick	....do	25.00
2	9	Gottlieb Jahnke	....do	25.00
2	10	Jerry Parkinson	....do	25.00
2	11	John Lewis	....do	25.00
2	12	Richard E. Rice	....do	25.00
2	13	James Clear	....do	30.00
2	14	A. H. Pape	....do	5.00
2	15	Charles Rogers	....do	25.00
2	16	Axel Fahlstrom	....do	25.00
2	17	John Kilawee	....do	30.00
2	18	Alexander G. Grignon	....do	30.00
2	19	Cornelius Romsom	....do	30.00
2	20	Henry C. Bongers	....do	25.00
3	21	Frank B. Fargo	Papering, etc	4.90
3	22	Schlafer Hardware Co	Packing, etc	2.70
3	23	Gerry Lumber Co	Lumber	14.88
3	24	J. H. Marston & Co	Mortar, etc	16.62
3	25	Appleton Machine Co	Bolts, etc	19.25
3	26	Ramsay & Jones	Lumber, etc	84.28
3	27	Wisconsin Telephone Co	Rent of telephones	7.50
3	28	....do	Telephone messages	12.02
3	29	William Diehmann	Rent of office	25.00
3	30	H. C. Doman	Babbitt metal, etc	28.53
3	31	The Cook & Brown Lime Co	Coal	5.40
3	32	Conlee Lumber Co	Pine lumber	138.70
3	33	Campbell & Cameron Co	Pine and oak lumber	151.73
3	34	Hay Hardware Co	Iron, etc	202.99
3	35	Priest & Gorrow	Wood and coal	285.05
3	36	A. J. Weir	Lumber	.83
3	37	E. W. Moran	Meat, etc	7.02
3	38	The Marsh & Bingham Co	Pine timber	2,879.46
3	39	Mann Bros	Oak lumber	127.81
3	40	E. F. Petruschke & Son	Laundry	1.30
3	41	A. A. Brewster	Traveling expenses	2.84
3	42	L. M. Mann	....do	16.10
5	43	H. H. West Co	Book	7.00
5	44	....do	Pencils, etc	10.00
5	45	Western Union Telegraph Co	Telegram	.20
5	46	Hired men	Services, July, 1897	2,740.64
7	47	The R. P. Elmore Co	Cement	89.00
13	48	Capt. George A. Zinn	Mileage	10.54
13	49	Charles Sims	Services	9.00
13	50	Frank Marder	....do	13.75
13	51	George Vankuilen	....do	3.75
13	52	Charles M. Cole	Traveling expenses	11.91
20	53	Chicago, Milwaukee and St. Paul Rwy. Co.	Freight charges	1.77
20	54	Capt. George A. Zinn	Mileage	7.92
31	55	Fred. J. Anger	Services	60.00
31	56	L. M. Mann	....do	200.00
31	57	John M. Paige	....do	35.00
31	58	Roy Sims	....do	35.00
31	59	John Baeten	....do	25.00
31	60	George T. Allanson	....do	30.00
31	61	George Gifford	....do	25.00
31	62	John A. Banker	....do	25.00
31	63	Gabriel Wick	....do	25.00
31	64	Gottlieb Jahnke	....do	25.00
31	65	Jerry Parkinson	....do	25.00
31	66	John Lewis	....do	25.00
31	67	Richard E. Rice	....do	25.00
31	68	James Clear	....do	30.00
31	69	A. H. Pape	....do	5.00
31	70	Charles Rogers	....do	25.00
31	71	Axel Fahlstrom	....do	25.00
31	72	John Kilawee	....do	30.00
31	73	Alexander G. Grignon	....do	30.00
31	74	Cornelius Romsom	....do	30.00
31	75	Henry C. Bongers	....do	25.00
Sept. 2	1	L. Lindauer	Sand and stone	47.30

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
Sept. 2	2	Appleton Machine Co	Automatic valves	[illegible]
2	3	Valley Iron Works Manufacturing Co	Snubbing posts, etc	[illegible]
2	4	Wisconsin Telephone Co	Telephone messages	[illegible]
2	5	do	Rent of telephones	[illegible]
2	6	H. C. Doman	Iron castings, etc	[illegible]
2	7	Hay Hardware Co	Driftbolts, etc	[illegible]
2	8	William Dichmann	Rent of office	[illegible]
2	9	Priest & Gorrow	Wood	[illegible]
2	10	J. E. Wells & Co	Oars, etc	[illegible]
2	11	James Collins	Iron stubs, etc	104 [illegible]
2	12	The Marsh & Bingham Co	Pine timber, etc	1, 24[illegible]
2	13	L. M. Mann	Traveling expenses	[illegible]
2	14	John C. Beye	do	[illegible]
4	15	Hired men	Services, August, 1897	2. 64[illegible]
7	16	Yahr Bros	Steel	[illegible]
7	17	The Cook & Brown Lime Co	Coal	18. [illegible]
7	18	Western Lime and Cement Co	Cement	[illegible]
7	19	H. Niedecken Co	Stationery	11. [illegible]
11	20	Capt. George A. Zinn	Mileage	14. [illegible]
14	21	Fred Caverts	Services	4. [illegible]
14	22	Joseph Hittle	do	[illegible]
14	23	William L. Engel	Traveling expenses	1. [illegible]
16	24	A. Ross Houston	do	12. [illegible]
21	25	Orville Beach	Rent of land	25. 0[illegible]
24	26	Western Lime and Cement Co	Cement	14. 4[illegible]
24	27	Wm. Pankrats	Manure	1. 6[illegible]
24	28	A. J. Weir	Coal	13. [illegible]
24	29	Hiram Stedman	do	13. 46
29	30	H. C. Doman	Iron, etc	[illegible]
29	31	Hay Hardware Co	do	[illegible]
29	32	William Dichmann	Rent of office	[illegible]
29	33	J. A. Barnes	Tripods, etc	[illegible]
29	34	G. A. Krueger	Stone	67. [illegible]
29	35	Priest & Gorrow	Wood and coal	164. [illegible]
29	36	Lealie Clark	Labor	1. [illegible]
29	37	Ramsay & Jones	Pine lumber	49. [illegible]
29	38	Joseph Kloeckner, postmaster	Rent of post-office box	[illegible]
29	39	Wisconsin Telephone Co	Telephone messages	5.00
29	40	do	Rent of telephones	7.50
29	41	Western Union Telegraph Co	Telegram	[illegible]
29	42	The Cook & Brown Lime Co	Coal	18.00
29	43	Conlee Lumber Co	Pine lumber	395.31
30	44	Fred. J. Anger	Services	60.00
30	45	John M. Paige	do	35.00
30	46	Roy Sims	do	35.00
30	47	John Baeten	do	25.00
30	48	George T. Allanson	do	30.00
30	49	George Gifford	do	25.00
30	50	John A. Banker	do	25.00
30	51	Gabriel Wick	do	25.00
30	52	Gottlieb Jahnke	do	25.00
30	53	Jerry Parkinson	do	25.00
30	54	John Lewis	do	25.00
30	55	Richard E. Rice	do	25.00
30	56	James Clear	do	30.00
30	57	A. H. Pape	do	5.00
30	58	Charles Rogers	do	25.00
30	59	Axel Fahlstrom	do	25.00
30	60	John Kilawee	do	30.00
30	61	Alexander G. Grignon	do	30.00
30	62	Cornelius Romsom	do	30.00
30	63	Henry C. Bongers	do	25.00
30	64	L. M. Mann	do	200.00
30	65	Keuffel & Esser Co	Thumb tacks, etc	2.34
Oct. 4	1	S. J. Ebert	Traveling expenses	1.81
5	2	Hired men	Services, September, 1897	1,926.76
7	3	L. M. Mann	Traveling expenses	7.85
7	4	John C. Beye	do	7.12
9	5	D. A. Watt	do	11.80
16	6	Logan, Swift & Brigham Envelope Co	Envelopes, etc	36.10
16	7	Bailey Grover	Traveling expenses	3.41
18	8	Capt. George A. Zinn	Mileage	8.20
20	9	H. H. West Co	Stationery	14.56
23	10	Conlee Lumber Co	Pine lumber	80.99
23	11	Thiele & Handeyside	Clay	338.24
26	12	North Western Fuel Co	Coal	6.25
26	13	L. H. Battin	Oil	2.62
26	14	The Cook & Brown Lime Co	Coal	14.80
26	15	Robert Brand & Sons	Desk	20.00

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
Oct. 26	16	John H. Crawford & Co	Wood and coal	$332.45
27	17	Hay Hardware Co	Shovel, etc	1.00
27	18	William Dichmann	Lye, etc	3.31
27	19	Wall-Spalding Lumber Co	Piles	60.00
27	20	Priest & Gorrow	Wood and coal	166.95
27	21	Western Lime and Cement Co	Cement	18.00
28	22	Col. J. W. Barlow	Mileage	2.80
28	23	Hiram Stedman	Coal	28.25
28	24	A. J. Weir	do	22.34
28	25	M. A. Searl	Ice	5.00
28	26	Wisconsin Telephone Co	Telephone messages	4.00
28	27	Western Union Telegraph Co	Telegrams	.40
30	28	William Dichmann	Rent of office	25.00
30	29	Wisconsin Telephone Co	Rent of telephones	7.50
30	30	Fred. J. Anger	Services	60.00
30	31	L. M. Mann	do	200.00
30	32	John M. Paige	do	35.00
30	33	Roy Sims	do	35.00
30	34	John Baeten	do	25.00
30	35	George T. Allanson	do	30.00
30	36	George Gifford	do	25.00
30	37	Gabriel Wick	do	25.00
30	38	Gottlieb Jahnke	do	25.00
30	39	Jerry Parkinson	do	25.00
30	40	John Lewis	do	25.00
30	41	Richard E. Rice	do	25.00
30	42	James Clear	do	30.00
30	43	A. H. Pape	do	5.00
30	44	Charles Rogers	do	25.00
30	45	Axel Fahlstrom	do	25.00
30	46	John Kilawee	do	30.00
30	47	Alexander G. Grignon	do	30.00
30	48	Cornelius Romsom	do	30.00
30	49	Henry C. Bongers	do	25.00
Nov. 1	1	John A. Banker	do	25.00
4	2	August Schenemen	Stone	60.00
5	3	Hired men	Services, October, 1897	2,046.23
6	4	L. M. Mann	Traveling expenses	18.57
6	5	Charles M. Cole	do	3.40
6	6	Western Union Telegraph Co	Telegrams	1.20
10	7	D. A. Watt	Traveling expenses	.99
10	8	John C. Beye	do	11.65
10	9	Williamson & Libbey Lumber Co	Storm windows	5.40
10	10	Brauns & Van	Meat, etc	13.06
10	11	Bailey Grover	Traveling expenses	2.25
10	12	Des Forges & Co	Paper, etc	3.87
11	13	Eugene Dietzgen Co	Tracing cloth, etc	8.58
11	14	E. F. Petruschke & Son	Laundry	2.78
20	15	Conlee Lumber Co	Lumber, etc	529.33
20	16	H. C. Doman	Davits	10.92
23	17	Wm. Pankrats	Manure	1.50
23	18	L. Lindauer	Stone	164.50
23	19	Mann Bros	Pine lumber	375.32
24	20	J. A. Barnes	Tripods, etc	147.29
26	21	Adolph Green	Driving piles	39.00
26	22	The Cook & Brown Lime Co	Coal, etc	45.02
26	23	Schlafer Hardware Co	Spikes, etc	95.08
27	24	Orville Beach	Rent of land	25.00
27	25	C. S. Morris	Brick	11.40
27	26	Hiram Stedman	Coal and wood	97.25
27	27	Priest & Gorrow	Wood, coal, and stone	536.86
30	28	Western Union Telegraph Co	Telegrams	.40
30	29	Hay Hardware Co	Sounding line, etc	1.87
30	30	Wisconsin Telephone Co	Rent of telephones	7.50
30	31	do	Telephone messages	9.55
30	32	William Dichmann	Rent of office	25.00
30	33	L. M. Mann	Services	200.00
30	34	John M. Paige	do	35.00
30	35	Roy Sims	do	35.00
30	36	John Baeten	do	25.00
30	37	George T. Allanson	do	30.00
30	38	George Gifford	do	25.00
30	39	Gabriel Wick	do	25.00
30	40	Gottlieb Jahnke	do	25.00
30	41	Jerry Parkinson	do	25.00
30	42	John Lewis	do	25.00
30	43	Richard E. Rice	do	25.00
30	44	James Clear	do	30.00
30	45	A. H. Pape	do	5.00

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Itemized statement of expenses made from appropriation for operating and care and other works of navigation, indefinite, act of July 5, 1884, etc.—Continu

Date.	No. of voucher.	To whom paid.	For what paid.
1897.			
Nov. 30	46	Charles Rogers	Services
30	47	Axel Fahlstrom	do
30	48	John Kilawee	do
30	49	Alexander G. Grignon	do
30	50	Cornelius Romsom	do
30	51	Henry C. Bongers	do
30	52	John A. Banker	do
Dec. 3	1	L. M. Mann	Traveling expenses
3	2	W. S. Woodworth	do
3	3	D. A. Watt	do
3	4	John C. Beye	do
4	5	Hired men	Services, November, 1897
4	6	Daniel W. Chipman	Traveling expenses
10	7	Berlin & Montello Granite Co	Stone
13	8	Capt. George A. Zinn	Mileage
14	9	Charles M. Cole	Traveling expenses
16	10	William J. Schoek	Services
17	11	Burdick, Armitage & Allen	Job printing
20	12	Hollis Stedman & Sons	Tallow
20	13	Hiram Stedman	Coal
20	14	C. A. Peck	Nails, etc
20	15	Valley Iron Works Manufacturing Co	Spar plates
20	16	Keuffel & Esser Co	Blue-print paper
22	17	The Marsh & Bingham Co	Oak lumber
23	18	Tiny Smith	Hire of jackscrews
23	19	Conlee Lumber Co	Pine lumber
23	20	J. A. Barnes	Spar plates
23	21	Peter Diedrich	Traveling expenses
23	22	Hired men	Services
24	23	Mann Bros	Pine and oak lumber
24	24	Jones & Laughlins, Limited	Spikes, etc
24	25	A. A. Brewster	Traveling expenses
31	26	Fred. J. Anger	Services
31	27	John M. Paige	do
31	28	Roy Sims	do
31	29	John Baeten	do
31	30	George T. Allanson	do
31	31	George Gifford	do
31	32	Gabriel Wick	do
31	33	Gottlieb Jahnke	do
31	34	Jerry Parkinson	do
31	35	John Lewis	do
31	36	Richard R. Rice	do
31	37	James Clear	do
31	38	A. H. Pape	do
31	39	Charles Rogers	do
31	40	Axel Fahlstrom	do
31	41	John Kilawee	do
31	42	Alexander G. Grignon	do
31	43	Cornelius Romsom	do
31	44	Henry C. Bongers	do
31	45	The Keith Lumber Co	Oak lumber
31	46	Adam D. Sheriff	Stone
31	47	Joseph Kloeckner, postmaster	Rent of post-office box
31	48	Wisconsin Telephone Co	Telephone messages
31	49	do	Rent of telephones
31	50	William Dichmann	Rent of office
31	51	L. M. Mann	Services
31	52	John A. Banker	do
31	53	H. Niedecken Co	Stationery
31	54	L. M. Mann	Traveling expenses
31	55	John C. Beye	do
1898.			
Jan. 8	1	Gottlieb Luedtke	Hire of tools, etc
8	2	D. A. Watt	Traveling expenses
8	3	Charles M. Cole	do
8	4	Bailey Grover	do
8	5	Hired men	Services, December, 1897
19	6	Chicago, Milwaukee and St. Paul Rwy. Co	Freight charges
19	7	William Jacobs	Services
26	8	Butler Bros	Babbitt metal, etc
26	9	L. Lindauer	Coal
26	10	Stark & Tesch	Tool steel, etc
26	11	Schlafer Hardware Co	Wire fencing, etc
26	12	Ramsay & Jones	Fence posts, etc
26	13	H. Channon Co	Drill, etc
26	14	Mann Bros	Oak timber
26	15	Western Lime and Cement Co	Cement
31	16	L. M. Mann	Services

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1898.				
Jan. 31	17	John M. Paige	Services	$35.00
31	18	Roy Sims	....do	35.00
31	19	John Baeten	....do	25.00
31	20	George T. Allanson	....do	30.00
31	21	George Gifford	....do	25.00
31	22	Gabriel Wick	....do	25.00
31	23	Gottlieb Jahnke	....do	25.00
31	24	Jerry Parkinson	....do	25.00
31	25	John Lewis	....do	25.00
31	26	James Clear	....do	30.00
31	27	A. H. Pape	....do	5.00
31	28	Charles Rogers	....do	25.00
31	29	Axel Fahlstrom	....do	25.00
31	30	John Kilawee	....do	30.00
31	31	Alexander G. Grignon	....do	30.00
31	32	Cornelius Romsom	....do	30.00
31	33	Henry C. Bongers	....do	25.00
31	34	Richard E. Rice	....do	25.00
Feb. 3	1	L. M. Mann	Traveling expenses	8.37
3	2	Gillingham & Son	Steel, etc	11.25
3	3	William Dichmann	Rent of office	25.00
3	4	Wisconsin Telehone Co	Rent of telephone	4.17
3	5	....do	Telephone messages	1.75
3	6	John A. Banker	Services	25.00
4	7	Hired men	Services, January, 1898	2,912.56
16	8	Torrey Cedar Co	Cedar posts, etc	31.25
16	9	Burdick, Armitage & Allen	Job printing	16.95
16	10	H. Voss	Lettering books	1.35
16	11	M. J. Schmitt	Blue prints, etc	12.99
16	12	Charles M. Cole	Traveling expenses	11.77
16	13	John C. Beye	....do	39.67
16	14	Bailey Grover	....do	49.34
16	15	Fred Cavert	Services	1.50
19	16	Orville Beach	Rent of land	25.00
26	17	G. W. Jones Lumber Co	Lumber	595.54
28	18	Fred. J. Anger	Services	60.00
28	19	P. D. Cunningham	....do	125.00
28	20	L. M. Mann	....do	200.00
28	21	John M. Paige	....do	35.00
28	22	Roy Sims	....do	35.00
28	23	John Baeten	....do	25.00
28	24	George T. Allanson	....do	30.00
28	25	George Gifford	....do	25.00
28	26	John A. Banker	....do	25.00
28	27	Gabriel Wick	....do	25.00
28	28	Gottlieb Jahnke	....do	25.00
28	29	Jerry Parkinson	....do	25.00
28	30	John Lewis	....do	25.00
28	31	Richard E. Rice	....do	25.00
28	32	James Clear	....do	30.00
28	33	A. H. Pape	....do	5.00
28	34	Charles Rogers	....do	25.00
28	35	Axel Fahlstrom	....do	25.00
28	36	John Kilawee	....do	30.00
28	37	Alexander G. Grignon	....do	30.00
28	38	Cornelius Romsom	....do	30.00
28	39	Henry C. Bongers	....do	25.00
28	40	Western Union Telegraph Co	Telegram	.21
28	41	Hay Hardware Co	Leather, etc	2.06
28	42	Wisconsin Telephone Co	Rent of telephone	4.17
28	43	....do	Telephone messages	2.80
28	44	William Dichmann	Rent of office	25.00
28	45	Butler Bros	Pails, etc	2.88
28	46	Western Lime and Cement Co	Cement	350.00
28	47	Wm. A. Lambie	Sand	167.20
28	48	Bailey Grover	Traveling expenses	16.83
Mar. 3	1	G. K. Kendall	Paper, etc	53.74
3	2	Capt. George A. Zinn	Mileage	8.96
3	3	Hired men	Services, Feb., 1898	2,883.29
5	4	L. M. Mann	Traveling expenses	7.84
5	5	John C. Beye	....do	3.23
5	6	Eugene Dietzgen Co	Positive prints, etc	19.57
8	7	Charles M. Cole	Traveling expenses	11.27
12	8	Eugene Dietzgen Co	Drawing paper, etc	18.34
19	9	Herman Voss	Paper tubes	19.20
23	10	Rodney Sacket & Co	Spikes, etc	16.12
23	11	John V. Bunn	Directory	5.00
23	12	Western Lime and Cement Co	Cement	175.00
26	13	Joys Bros. & Co	Oakum, etc	117.15

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Itemized statement of expenses made from appropriation for
and other works of navigation, indefinite, act of July 5,

Date.	No. of voucher.	To whom paid.	
1898.			
Mar. 26	14	Stark & Teach	Black
26	15	The Marsh & Bingham Co	Lumb
31	16	Joseph Kloeckner, postmaster	Rent
31	17	William Diehmann	Rent
31	18	Appleton Machine Co	Gas p
31	19	Valley Iron Works Manufacturing Co	Valve
31	20	Western Union Telegraph Co	Telegr
31	21	Wisconsin Telephone Co	Rent
31	22	do	Teleph
31	23	L. M. Mann	Servic
31	24	John M. Paige	do
31	25	Roy Sims	do
31	26	John Baeten	do
31	27	George T. Allanson	do
31	28	George Gifford	do
31	29	Gabriel Wick	do
31	30	Gottlieb Jahnke	do
31	31	Jerry Parkinson	do
31	32	John Lewis	do
31	33	Richard E. Rice	do
31	34	James Clear	do
31	35	A. H. Pape	do
31	36	Charles Rogers	do
31	37	Axel Fahlstrom	do
31	38	John Kilawee	do
31	39	Alexander G. Grignon	do
31	40	Cornelius Romsom	do
31	41	Henry C. Bongers	do
31	42	John A. Banker	do
31	43	L. Lindauer	Stone
31	44	L. M. Mann	Travel
Apr. 4	1	Hired men	Service
11	2	Charles M. Cole	Travel
11	3	M. J. Schmitt	Blue p
11	4	H. Niedecken	Station
11	5	Michael Niesen	Service
16	6	George Verkuilen	do
16	7	Capt. George A. Zinn	Mileag
21	8	Logan, Swift & Brigham Envelope Co	Envelo
21	9	Eugene Dietzgen Co	Blue p
21	10	Keuffel & Esser Co	Chinese
21	11	Hiram Stedman	Blacksm
28	12	C. E. Angell & Co	Seeds
28	13	Western Lime and Cement Co	Cement
28	14	James E. Patton Co	Boiled
28	15	The Marsh & Bingham Co	Lumber
28	16	John H. Crawford & Co	Coal
28	17	Thos. Jackson	Iron, et
28	18	Kankauna Lumber and Mfg. Co	Oak lum
28	19	Butler Bros	Lag scr
28	20	Valley Iron Works Manufacturing Co	Tripods
28	21	National Paint Works	Paint
30	22	Fred. J. Anger	Service
30	23	L. M. Mann	do
30	24	John M. Paige	do
30	25	Roy Sims	do
30	26	John Baeten	do
30	27	George T. Allanson	do
30	28	George Gifford	do
30	29	John A. Banker	do
30	30	Gabriel Wick	do
30	31	Gottlieb Jahnke	do
30	32	Jerry Parkinson	do
30	33	John Lewis	do
30	34	Richard E. Rice	do
30	35	James Clear	do
30	36	A. H. Pape	do
30	37	Charles Rogers	do
30	38	Axel Fahlstrom	do
30	39	John Kilawee	do
30	40	Alexander G. Grignon	do
30	41	Cornelius Romsom	do
30	42	Henry C. Bongers	do
30	43	L. Lindauer	do
30	44	Conlee Lumber Co	Stone
30	45	William Diehmann	Pine lum
30	46	Wisconsin Telephone Co	Rent of
30	47	do	Rent of
May 3	1	John C. Beye	Telephon
			Travelin

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Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1898.				
May 4	2	D. A. Watt	Traveling expenses	$2.75
4	3	I. H. Battin	Oil, etc	61.03
5	4	Hired men	Services, Apr., 1898	2,556.01
14	5	M. J. Schmitt	Blue prints, etc	17.76
14	6	Western Union Telegraph Co	Telegram	.20
14	7	William A. Lambie	Sand	146.30
14	8	Charles M. Cole	Traveling expenses	15.91
14	9	L. M. Mann	....do	9.52
21	10	Orville Beach	Rent of land	25.00
21	11	Harry W. Donner	Services	12.50
31	12	A. Ross Houston	....do	200.00
31	13	L. M. Mann	....do	200.00
31	14	John M. Paige	....do	35.00
31	15	Roy Sims	....do	35.00
31	16	John Baeten	....do	25.00
31	17	George T. Allanson	....do	30.00
31	18	George Gifford	....do	25.00
31	19	Gabriel Wick	....do	25.00
31	20	Gottlieb Jahnke	....do	25.00
31	21	Jerry Parkinson	....do	25.00
31	22	John Lewis	....do	25.00
31	23	Richard E. Rice	....do	25.00
31	24	James Clear	....do	30.00
31	25	A. H. Pape	....do	5.00
31	26	Charles Rogers	....do	25.00
31	27	Axel Fahlstrom	....do	25.00
31	28	John Kilawee	....do	30.00
31	29	Alexander G. Grignon	....do	30.00
31	30	Cornelius Romsom	....do	30.00
31	31	Henry C. Bongers	....do	25.00
31	32	L. Lindauer	Crushed stone	18.75
31	33	J. H. Marston & Co	Wood	19.50
31	34	Schlafer Hardware Co	Hose, rope, etc	115.26
31	35	Western Union Telegraph Co	Telegram	.20
31	36	Stroud & Thomson	Paint, etc	.70
31	37	J. A. Barnes	Gas pipe, etc	.77
31	38	H. C. Johnson & Son	Storing awnings, etc	1.75
31	39	Wisconsin Telephone Co	Rent of telephone	4.17
31	40	....do	Telephone messages	6.70
31	41	John H. Crawford & Co	Coal	16.28
31	42	William Dichmann	Rent of office	25.00
31	43	....do	Soap, lye, etc	52.96
31	44	Hay Hardware Co	Rope, waste, etc	106.70
31	45	The Cook & Brown Lime Co	Coal	140.00
31	46	Priest & Gorrow	Wood	464.63
31	47	Joys Bros. & Co	Pitch	3.00
31	48	John A. Banker	Services	25.00
31	49	C. E. Angell & Co	Seeds	.41
June 3	1	L. M. Mann	Traveling expenses	8.01
3	2	D. A. Watt	....do	1.01
3	3	Charles M. Cole	....do	9.83
4	4	Hired men	Services, May, 1898	2,451.41
9	5	James Jones	....do	27.00
9	6	James Murphy	....do	1.25
10	7	Peter Diedrich	....do	12.00
10	8	M. J. Schmitt	Sepia prints, etc	1.16
13	9	D. A. Watt	Services	41.67
13	10	A. A. Brewster	Traveling expenses	4.31
16	11	Andrew Mills	American ensign	6.25
16	12	Eugene Dietzgen Co	Blue-print frame, etc	25.67
16	13	The Marsh & Bingham Co	Oak timber	51.24
16	14	W. S. Woodworth	Traveling expenses	6.57
29	15	Priest & Gorrow	Wood	338.62
29	16	Ole Oleson	Rent of post-office box	.75
29	17	Western Union Telegraph Co	Telegrams	.80
29	18	Wisconsin Telephone Co	Rent of telephone	4.17
29	19	....do	Telephone messages	7.10
29	20	William Dichmann	Rent of office	25.00
29	21	Campbell & Cameron Co	Cedar piles	127.50
29	22	Hay Hardware Co	Sheet iron, etc	4.20
30	23	Edward Bradley	Office rent	75.00
30	24	Fred. J. Anger	Services	60.00
30	25	John H. Crawford	Coal	119.59
30	26	L. M. Mann	Services	200.00
30	27	John M. Paige	....do	35.00
30	28	Charles Sims	....do	35.00
30	29	John Baeten	....do	25.00
30	30	George T. Allanson	....do	30.00
30	31	George Gifford	....do	25.00

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Itemized statement of expenses made from appropriation for ope and other works of navigation, indefinite, act of July 5, 18

Date.	No. of voucher.	To whom paid.	For
1898.			
June 30	32	John A. Banker	Services
30	33	Gabriel Wick	do
30	34	Gottlieb Jahnke	do
30	35	Jerry Parkinson	do
30	36	John Lewis	do
30	37	Richard E. Rice	do
30	38	James Clear	do
30	39	A. H. Pape	do
30	40	Charles Rogers	do
30	41	Axel Fahlstrom	do
30	42	John Kilawee	do
30	43	Alexander G. Grignon	do
30	44	Cornelius Romsom	do
30	45	Henry C. Bongers	do
30	46	L. M. Mann	Travelin
		Total	

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Baltimore Harbor, Md ..... I, 177; II, 1181
Bass River Light Station, Mass ..... I, 84, 932
Block Island Sound, R. I., off Quonocontaug ..... I, 84, 931
Brunswick Harbor, Ga ..... I, 231; II, 1321
Cape Cod, near Orleans, Mass ..... I, 69, 883
Cape Henry Light, Va ..... I, 201; II, 1235
Chatham Harbor, Mass ..... I, 69, 883
Chesapeake Bay, Md ..... I, 175, 201; II, 1172, 1235
Christiana River, Del ..... I, 175; II, 1172
Columbia River, Oreg., below Tongue Point ..... I, 507; IV, 3039
Darien Harbor, Ga ..... I, 231; II, 1320
Davis Strait, Me ..... I, 52, 838
Deer Island Thoroughfare, Me ..... I, 52, 838
Delaware Bay (schooner *Lottie K. Friend*) ..... I, 156; II, 1104
Duluth Harbor, Minn ..... I, 385; III, 2287

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Wrecks, removal of—Continued.
Elizabeth River, Va. (steamer *Helen Smith*)
Elk River, Md
James River, Va. (steamer *Wyanoke*)
Key West, Fla., Man of War Harbor
Killpond Bar, Mass.
Little Egg Harbor Inlet, N. J
Man of War Harbor, Key West, Fla.
Marthas Vineyard, Mass., Vineyard Haven Harbor
Maurice River, N. J.
Millbridge, Me
Mississippi River
Monroe Harbor, Mich
Narraguagus Bay, Me
Newark Bay, N. J
Newport News, Va. (steamer *Wyanoke*)
Newtown Creek, N. Y
New York Harbor, N. Y. 1, 12
Norfolk Harbor, Va. (steamer *Helen Smith*)
Ocmulgee River, Ga
Old Harbor, Chatham, Mass.
Orleans, Mass
Patapsco River at Baltimore, Md
Philadelphia, Pa
Pontchartrain Lake, La
Quonocontaug, R. I
Raisin River, Mich., in Monroe Harbor
Schuylkill River, Pa
Smyrna River, Del
Superior Bay, Minn
Tongue Point, Columbia River, Oreg., below
Urbana Creek, Va.
Vineyard Haven Harbor, Mass
Vineyard Sound, Mass
Wilmington, Del., Christiana River
Wyanoke (steamer), removal of wreck of.
Wyoming, examination of reservoir sites in

Y.

Yalobusha River, Miss., construction of bridge across,
Yamhill River, Oreg., improvement of
Yaquina Bay, Oreg., improvement of
Yaquina River, Oreg., examination of
Yazoo and Mississippi Valley Railroad Company, bridg
Yazoo River, Miss.:
Bridge at Greenwood, construction of
Improvement at mouth, including Vicksburg Harb
Improvement of
Yellow Mill Pond, Bridgeport Harbor, Conn.:
Construction of bridge across
Improvement of (*see* Bridgeport Harbor)
Yellowstone River, Mont. and N. Dak., improvement o
Yonkers, N. Y., establishment of harbor lines in Hudso
York River, Va., improvement of
Youghiogheny River, Pa., reconstruction of bridge acr
port and Reynoldton
Youngs Bay, Oreg., construction of bridge across

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